FEBRUARY
1953

MECHANICAL ENGINEERING

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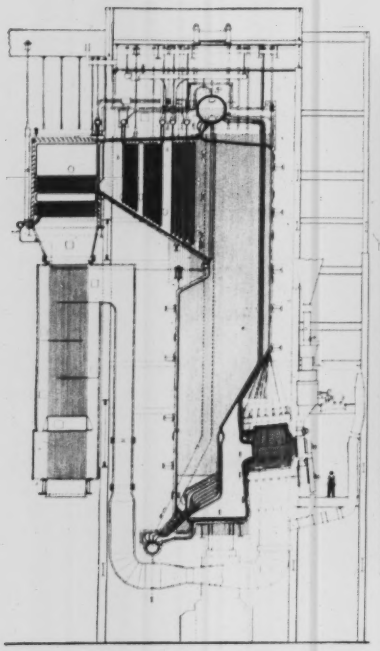
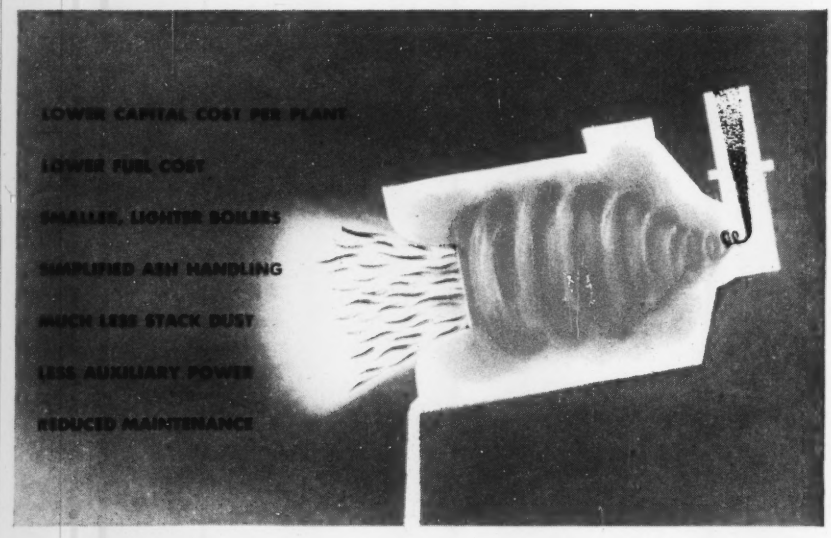
ASME Spring Meeting—Columbus, Ohio, April 28-30, 1953

Steam is literally the lifeblood of our American economy. Through it, the energy in our store of fuels is made available in useable form. Steam has always been taken for granted because it's cheap. But, with the depletion of top grade coals, with the increase in price of fuels generally, major engineering concentration is required on the problem of.....

keeping steam cheap

B&W *Cyclone* FURNACE





A prominent Eastern utility engineering executive calls the B&W Cyclone Furnace the most important development in the power plant field in the last 30 years . . . Another well-known utility executive ranks it with the steam turbine. We, in B&W, regard the Cyclone Furnace as one of our most important contributions to power plant engineering progress.

The Cyclone Furnace is important because it has simplified fuel-burning problems, and permitted efficient, economical use of a wide range of coals. More than a dozen different kinds of coal already have proved eminently satisfactory in service, and many more grades are showing promise under test.

Already, B&W's revolutionary method of coal-firing has been selected for a total of 32 boilers with aggregate steam capacity of more than twenty million pounds per hour . . . sufficient to serve over two million kw of new electric generating capacity.

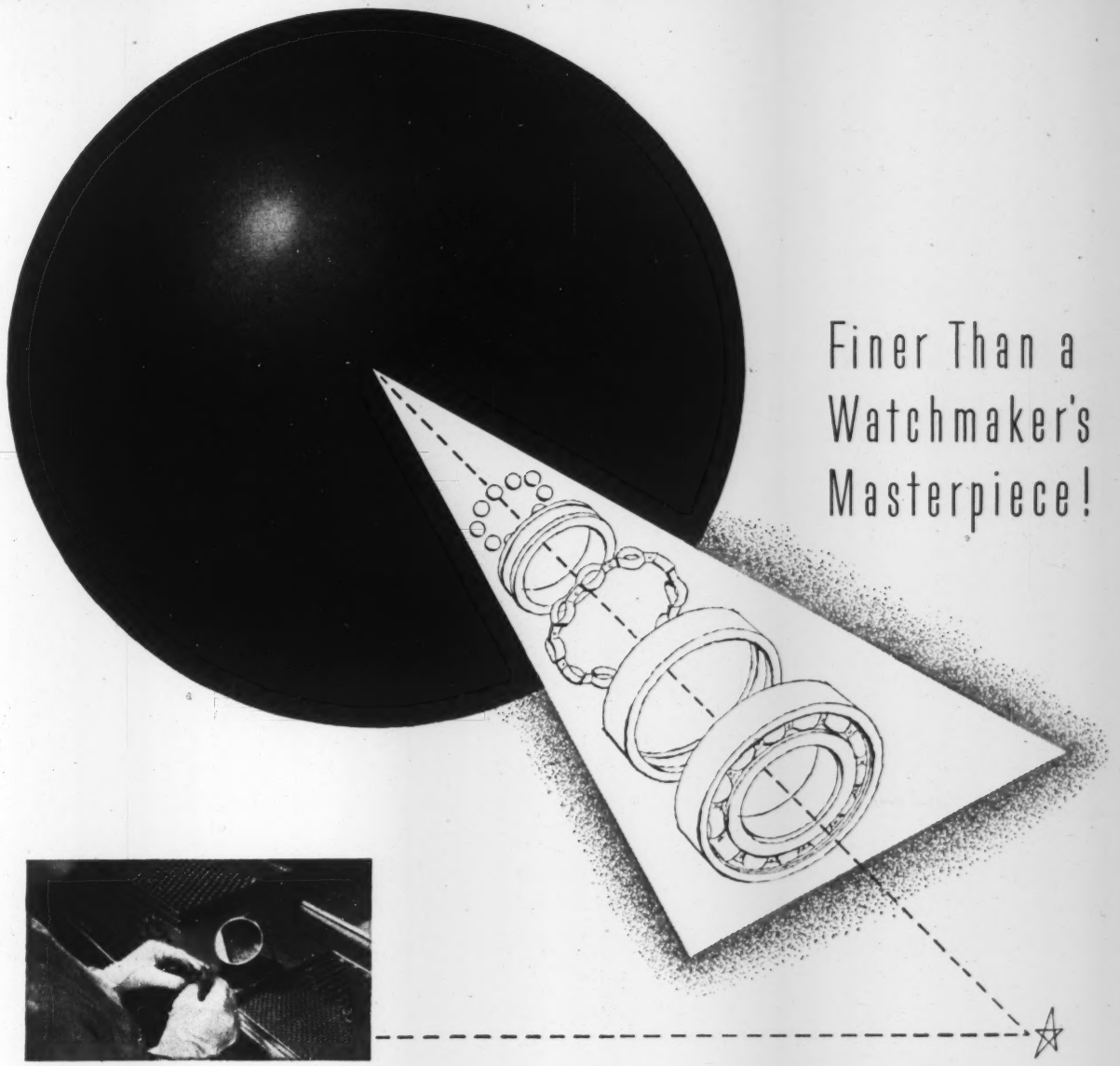
Keeping steam cheap... for public utilities and industrial users... is a prime engineering objective at B&W. The Cyclone Furnace is one of many B&W cost-saving advantages worth investigating.

BABCOCK & WILCOX

BOILER DIVISION

N-149

Finer Than a Watchmaker's Masterpiece!



This operation is typical of the laboratory-like techniques used on many precision bearings. The highly skilled operator is wearing special kid gloves to avoid contaminating the ball bearing.

New Departure ball bearings are quickly available at your equipment dealer or bearing distributor—supplied from the industry's largest nation-wide network of warehouse stocks.

NOTHING ROLLS LIKE A BALL

NEW DEPARTURE

BALL BEARINGS

NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONNECTICUT

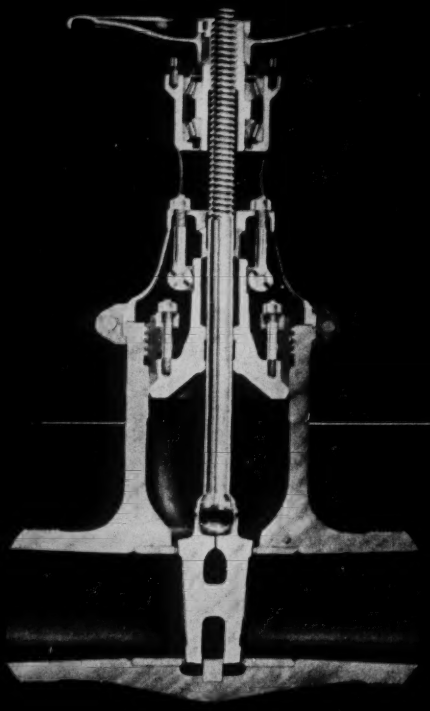
Also Makers of the Famous New Departure Coaster Brake

The finest products of the watchmaker's art do not reach the high level of precision attained by New Departure ball bearings. Manufacturing standards which insist on certain tolerances being held to millionths of an inch give these bearings the ability to provide the virtually friction-free support demanded by moving parts of machines.

In the metal working industry, New Departure "Sealed-for-Life" ball bearings make possible better design of machine tools. N-D-Seals eliminate the need of fixtures and lines for bearing lubrication . . . in many instances requiring less housing space and fewer parts.

Research, engineering and production at New Departure are focused on one major objective . . . making the *best* ball bearings for every kind of application. Keep your eye on the BALL to be sure of your BEARINGS!

MECHANICAL ENGINEERING, February, 1953, Vol. 75, No. 2. Published monthly by The American Society of Mechanical Engineers, at 20th and Northampton Sts., Easton, Pa. Editorial and Advertising departments, 29 West 39th St., New York 18, N. Y. Price to members and affiliates one year $3.50, single copy 50¢; to nonmembers one year $7.00, single copy 75¢. Postage to Canada, 75¢ additional, to foreign countries $1.50 additional. Entered as second-class matter December 21, 1920, at the Post Office at Easton, Pa., under the Act of March 3, 1879. Member of the Audit Bureau of Circulations.



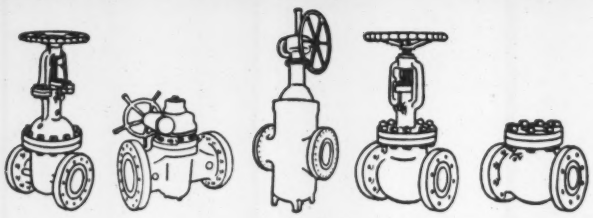
STEEL

COMPLETE LINES OF CAST STEEL VALVES AND PIPE FITTINGS are manufactured by Walworth in a variety of pressure classes, types, sizes, and patterns for general industrial use. Walworth also manufactures cast steel valves for specific service applications.

Walworth produces steel bar stock valves, and cast steel valves made of carbon steel, carbon molybdenum steel, corrosion-resistant, and heat-resistant alloy steels. Included are gate, globe, angle, check, and lubricated plug types. Sizes range from $\frac{1}{8}$ to 30 inches; pressures range up to 5,000 psi. Full information is contained in Walworth General Catalog 52, a copy of which will be forwarded if requested on business letterhead.

Walworth also manufactures complete lines of valves and fittings made of bronze, iron, and special alloys as well as steel. Walworth-made valves, fittings, and pipe wrenches total approximately 50,000 items.

Walworth engineers will be glad to help you with your problems. For full information, call your local Walworth distributor, nearest Walworth sales office, or write to Walworth Company, General Offices, 60 East 42nd Street, New York 17, New York.



Illustrated in section is an 8-inch Series 900, Walworth Pressure-Seal Cast Steel Gate Valve designed for high-pressure, high-temperature service. Pressure-Seal Valves are available in Series 600, 900, 1500 and 2500; sizes 1 to 16 inches. Small Cast Steel Valves, Series 1500, in angle and Y-globe types, are also available in sizes ranging from $\frac{1}{4}$ to 2 inches.

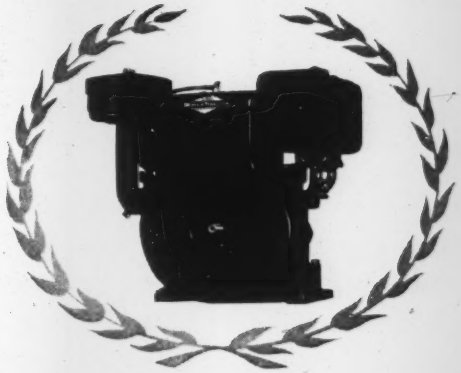
WALWORTH

Manufacturers since 1842

valves . . . pipe fittings . . . pipe wrenches

60 East 42nd Street, New York 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



1,000,000

INDUSTRIAL ENGINES

built in ONE year

It's a new world production record — never before accomplished. For 33 years BRIGGS & STRATTON has been establishing a long list of firsts. And now, in 1952, another is added.

BRIGGS & STRATTON is recognized as the pioneer and the leader in its field . . . setting new standards, year after year in engineering, in design, in engine performance and in precision mass production.

Whether you are a manufacturer, dealer or user of gasoline engine powered equipment — you are assured of top performance when you specify BRIGGS & STRATTON 4-cycle, single cylinder, air-cooled engines. They are the "preferred power" value all over the world.

BRIGGS & STRATTON CORPORATION
Milwaukee 1, Wisconsin, U.S.A.

4 CYCLE
BRIGGS & STRATTON
GASOLINE ENGINES

BRIGGS & STRATTON 4-cycle, single cylinder, air-cooled engines are available from ¾ to 8¼ hp. — in many models and types. They are preferred power for hundreds of types of machines, tools and appliances. All are backed by a world-wide service organization, factory supervised, unequalled in the industry.

In the automotive field, too, Briggs & Stratton is the recognized leader — and the world's largest producer of locks, keys, and related equipment.

All three Boilers at New Titus Station of the Metropolitan Edison Company

equipped with LJUNGSTROM AIR PREHEATERS

Adding on completion 240,000 kilowatts to the output of the Metropolitan Edison Company of Reading, Pa., the company's new Titus Station is now in operation producing 160,000 kilowatts. Designed and constructed by Gilbert Associates, Inc., of Reading, Pa., Titus is expected to be in capacity operation early next year.

Steam for each of the two 80,000-kw turbine-generators now in service, and for the third, soon to go into service, is supplied by a Combustion Engineering–Superheater Boiler at 1450 psi and 1000 F, reheated to 1000 F. These C-E Boilers are pulverized coal fired.

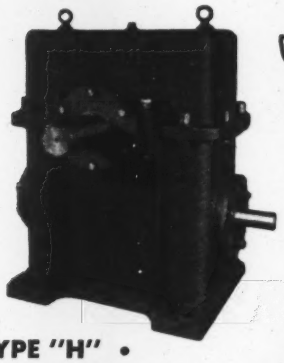
Each Combustion Boiler has been designed to incorporate two Ljungstrom Air Preheaters which preheat incoming combustion air to 600 F, and cool exit gases to 280 F.

At Titus, as at scores of power plant installations across the country, once again the broad general acceptance of the Ljungstrom Air Preheater for top efficiency steam generating units is demonstrated. Ljungstroms placed in service or on order since 1945 alone — selected by every major boiler manufacturer, consulting engineer and utility — are serving boilers with an aggregate capacity of over 285,000,000 pounds of steam per hour.

THE Air Preheater Corporation 60 East 42nd St., New York 17, N. Y.

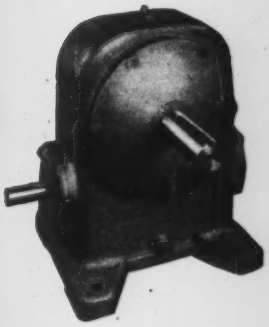
D.O.James

ESTABLISHED 1888



TYPE "H" •

Horizontal or Vertical Drive—Each drive type comes in 15 sizes, with ratio ranges of 5.6:1 to 100:1 and from .06 to 206 horsepower.



TYPE "S" •

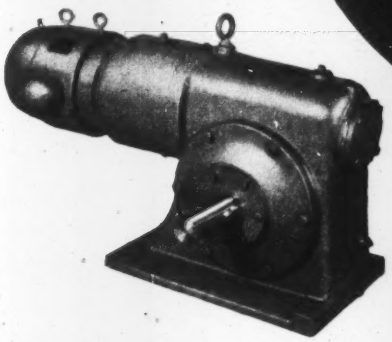
Horizontal or Vertical Drive—Each type available in 8 sizes, ratio range of 5.66:1 to 100:1 and from .04 to 15.6 horsepower.

for the Best in

WORM GEARS AND WORM GEAR REDUCERS

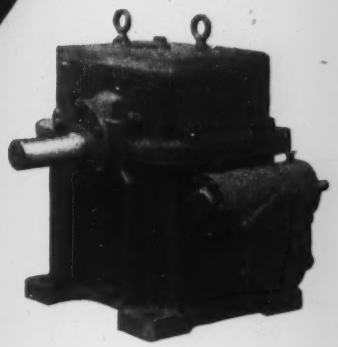
MOTORIZED •

Horizontal or Vertical Drive—Each drive type comes in 11 sizes, has ratio range of 5.6:1 to 100:1, with ⅛ to 30 horsepower, driven speeds of 310 r.p.m. to 17.4 r.p.m. Vertical drive slow speed shaft extends either upward or downward.



DOUBLE •

Horizontal or Vertical Drive—Each drive type available in 13 sizes, ratio range of 130:1 to 10000 and from .004 to 59.7 horsepower. Vertical drive slow speed shaft extends either upward or downward.

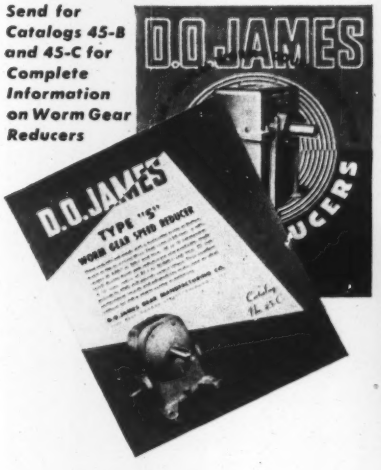


WORM GEARS

Generated on tangential feed hobbing machines by tapered and ground hobs. Made from 1" to 100" in diameter and from 24 DP to 1 DP.

Catalogs are available to users of Gears and Gear Reducers—containing valuable engineering data, specifications, weights and prices.

Send for Catalogs 45-B and 45-C for Complete Information on Worm Gear Reducers

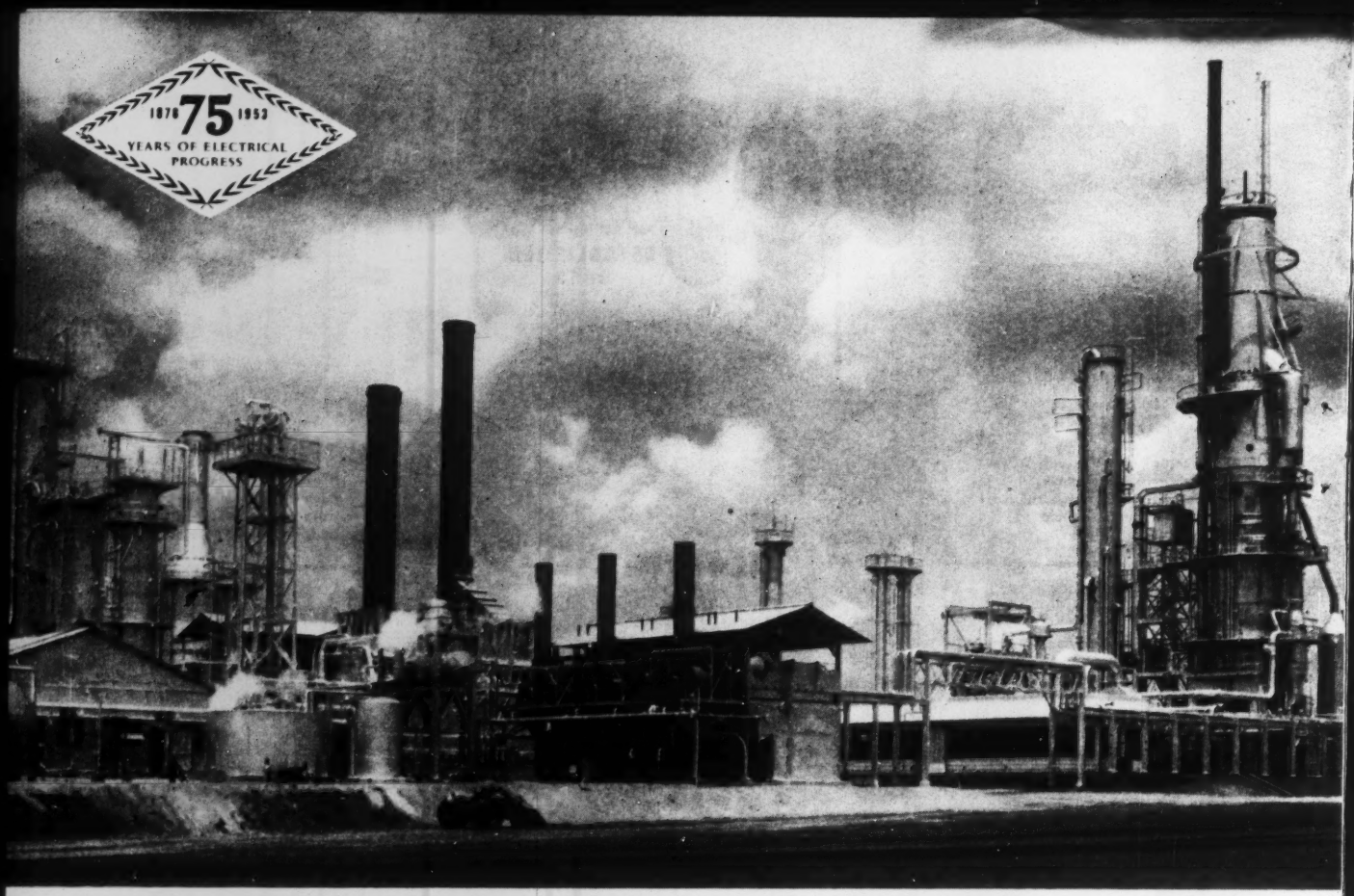


D. O. JAMES Worm Gears and Worm Gear Reducers are designed and manufactured to have maximum inbuilt strength and to assure dependable *on-the-job* performance. The many and repeated installations of these reducers testify to their operating superiority and adaptability.

D.O.James GEAR MANUFACTURING COMPANY

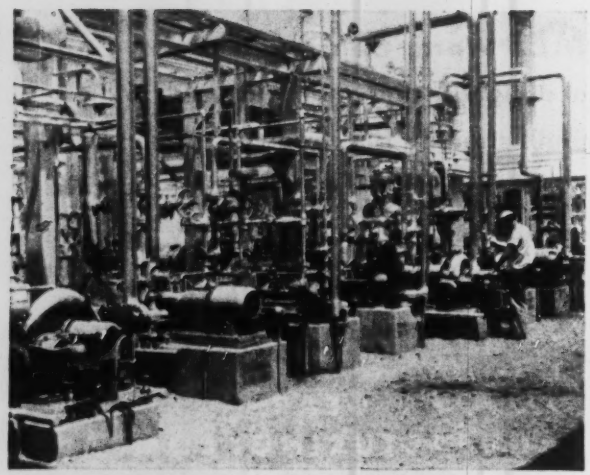
1140 WEST MONROE STREET • CHICAGO, ILLINOIS

SINCE 1888—MAKERS OF ALL TYPES OF GEARS AND GEAR SPEED REDUCERS

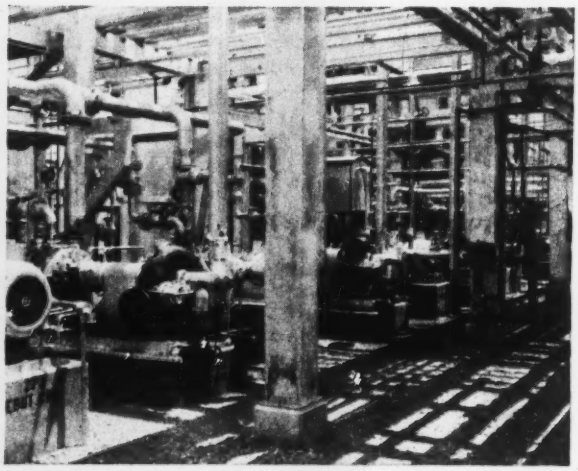


McMurrey Refining Company, Tyler, Texas, installed G-E mechanical-drive turbines throughout their plant to help assure continuous capacity output of 5000 bbls. per day.

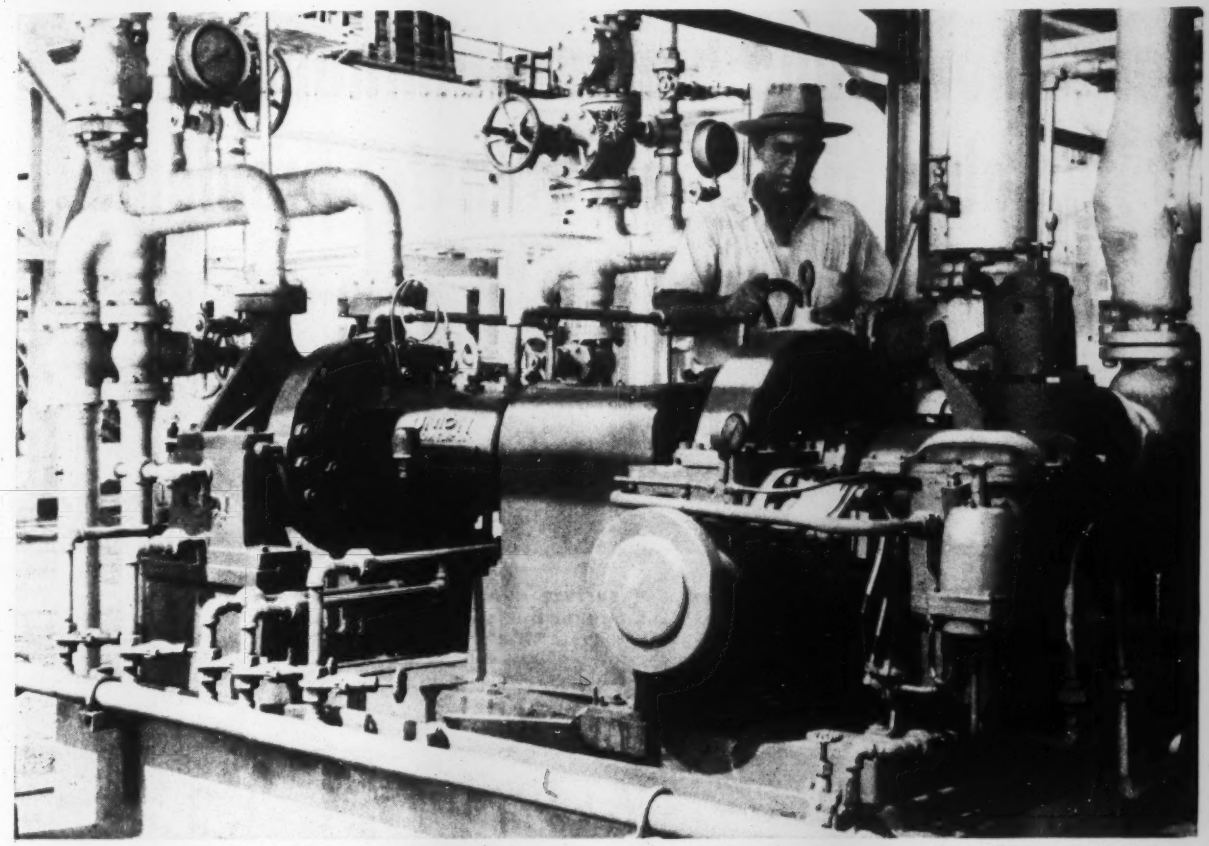
G-E Turbines Save Maintenance,



G-E turbines and motors are paired at McMurrey Refinery to utilize large steam supply efficiently. When process steam demands decrease, surplus steam is economically diverted to turbine drives. These Type DP turbines range from 8 hp to 41 hp.



Shown here is part of a row of ten General Electric Type DP turbine drives and motors, ranging from 9 hp to 48 hp. The many interchangeable parts on these turbines make stocking of spare parts an economical matter.



Maintenance personnel at the refinery have found this General Electric Type DP mechanical-drive turbine, like the many others at the refinery, easy to maintain. This 47-hp turbine at McMurrey Refinery drives a boiler-feed water pump.

Inventory Costs at McMurrey Refinery

Installed to improve steam balance, G-E standard turbines, with many interchangeable parts, also cut inventory costs.

The McMurrey Refinery, Tyler, Texas, installed General Electric mechanical-drive turbines to help regulate steam balance. Since process steam demands range from 30% to 70% of available supply, surplus steam is economically diverted to turbine drives.

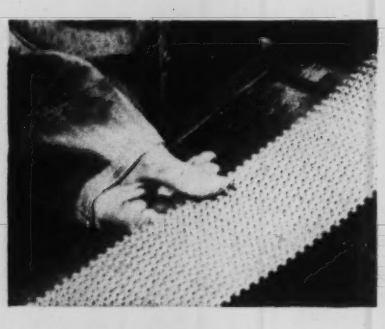
Time soon proved that General Electric turbine drives have many other advantages. Mr. Dave Hood, Mechanical Maintenance Foreman at the refinery, states, "With these turbines on the line now for over a year, we're happy to report that they are extremely easy and economical to maintain, requiring very little of our time for maintenance."

Mr. Hood also said, "Since we have quite a few different sizes and ratings of turbines here, we're particularly pleased with the great number of interchangeable parts on these turbines. It certainly cuts down our inventory problem." Interchangeability of a great majority of the replaceable parts (regardless of hp rating) is a big feature with G-E standard turbine drives, which are paired with motors throughout the refinery to help assure uninterrupted service.

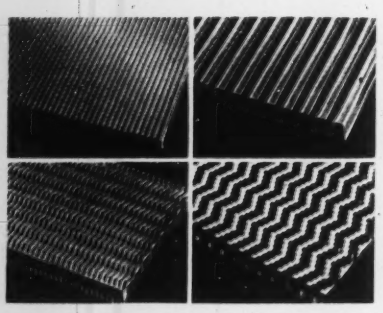
Call in your G-E sales-engineer or write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." Section 252-59, General Electric Company, Schenectady 5, N. Y.

GENERAL ELECTRIC

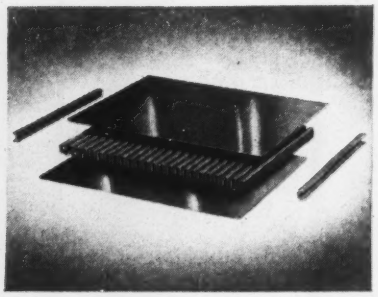
Here's how Trane brazes aluminum to solve tricky heat transfer problems...



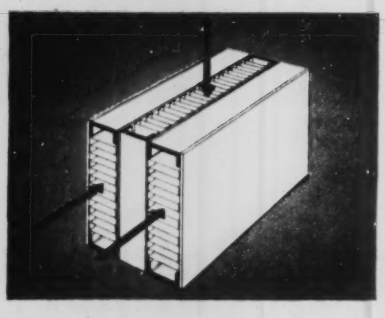
Corrugated fin surface for TRANE Brazed Aluminum Exchangers is formed in special presses from aluminum brazing sheet. Thickness can range from .005 to .032 inch; fin height to .50 inch; spacing 4 to 18 fins per inch.



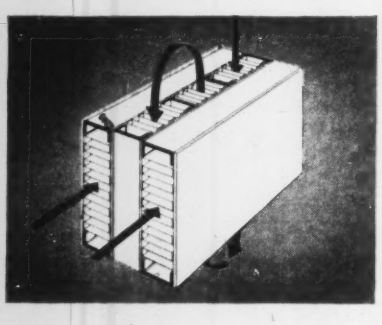
Many types of surface available. The brazed aluminum fins may be straight and continuous. Or they can be wavy, serrated or perforated to provide correct ratio of heat transfer to pressure drop.



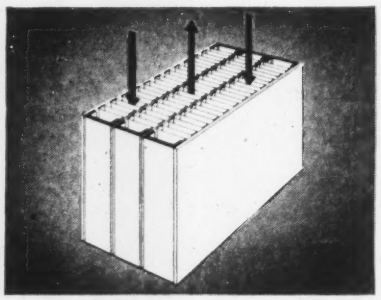
Exploded view shows component parts of a single passage. Fins, channels and parting sheets, all made from aluminum brazing sheet, become integrally bonded when assembled unit is submerged in a molten salt flux bath.



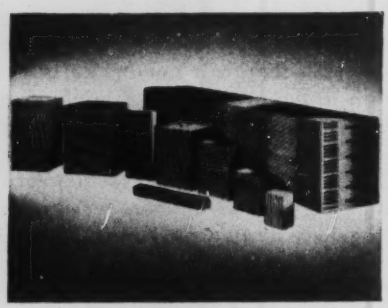
Cross-flow arrangement has fins in adjacent passages running crosswise to each other. TRANE Brazed Aluminum Surface can pack 450 square feet of heat transfer surface into one cubic foot of space.



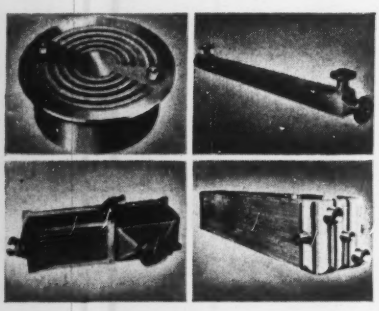
Multi-pass arrangement, like the cross-flow type, has fins in adjacent passages running crosswise to each other. With this arrangement, however, alternate passages are constructed to produce multiple passes.



Counter-flow arrangement has fins in adjacent passages running parallel to each other. A wide variety of different types of corrugated fin sheets can be used to handle different fluids in the same exchanger.



A wide range of core sizes is available up to 106 inches in length. Either bolt-on or integrally welded headers can be provided. Individual cores can be welded together to form larger multi-core units.



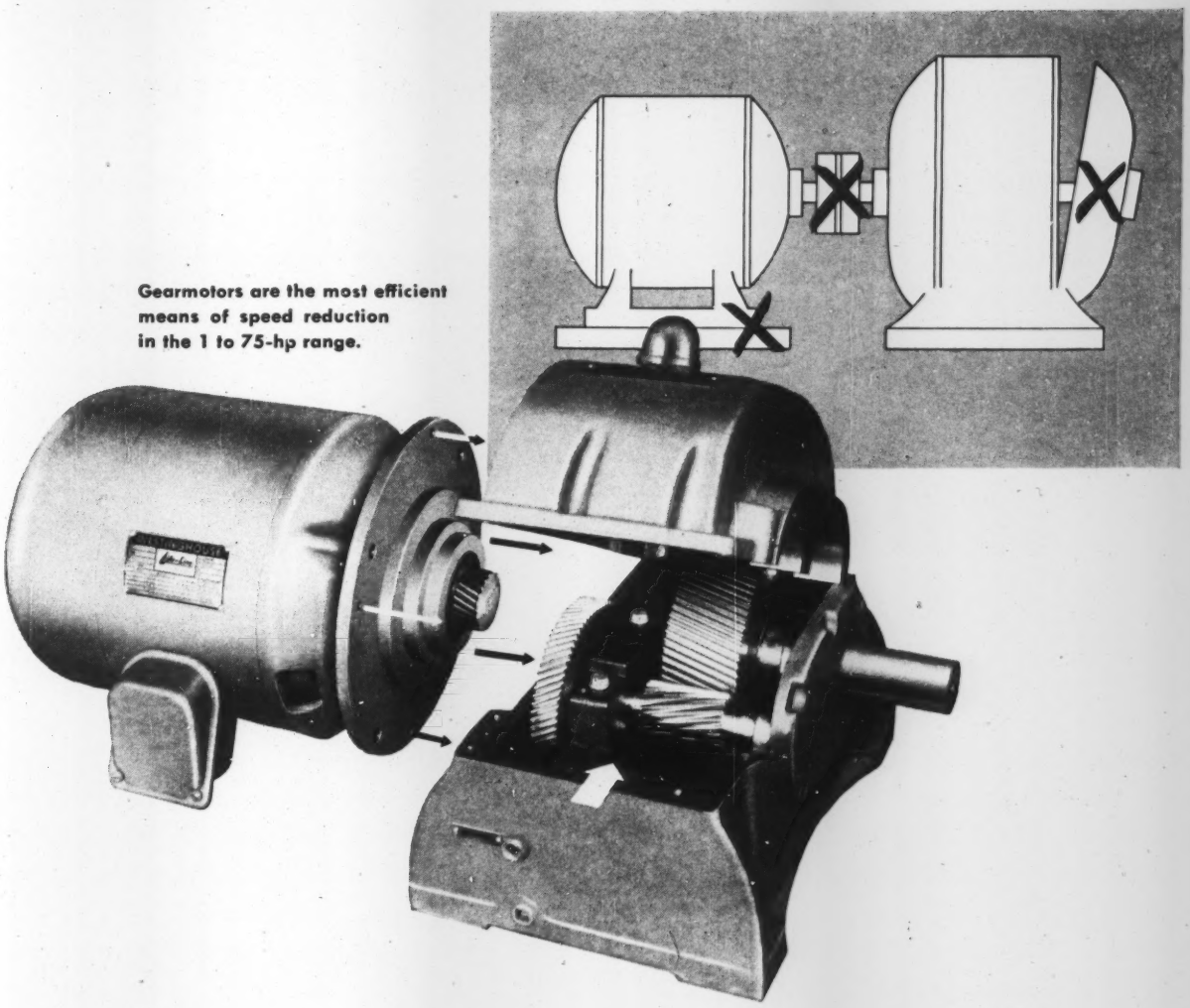
Design flexibility permits construction of units to handle practically any specification of heat transfer, pressure drop, volume, number and direction of passes. Some units handle as many as six different fluids simultaneously!

TRANE

pioneers in the science of heat exchange

If you have a tricky problem in heat transfer . . . TRANE Brazed Aluminum Exchangers may be the answer. Contact your TRANE Sales Office or write direct.

The Trane Company, La Crosse, Wis. • East. Mfg Div., Scranton, Penn. • Trane Co. of Canada, Ltd., Toronto.
80 U.S. and 14 Canadian Offices



Gearmotors are the most efficient means of speed reduction in the 1 to 75-hp range.

Here's why *Life-Line* GEARMOTORS stay on the job longer

LESS TIME OUT FOR SERVICING MOTOR

Removing the motor from a Life-Line gearmotor takes but a few minutes. Remove the motor mounting bolts and you are on your way—and, reassembly is just as simple and fast. Install the mounting bolts and the job's complete. No realigning of shafts—no coupling to adjust—no mounting feet to shim.

Should you be "on the spot" where down time is critical, this means that your spare motor can be quickly and easily installed. At the most, it is a simple assembly of the adapter bracket.

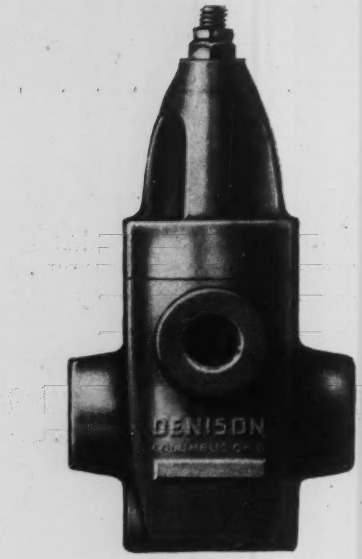
LESS TIME OUT FOR SERVICING GEARS

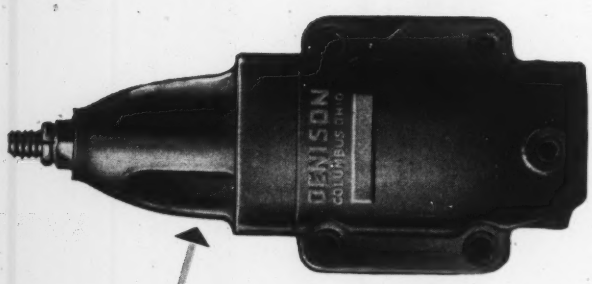
Here again, Life-Line's split case construction pays off. Simply by removing the top half of the gear case, the gears can be inspected or removed without touching the mounting bolts—without draining the oil—without disturbing the connected load.

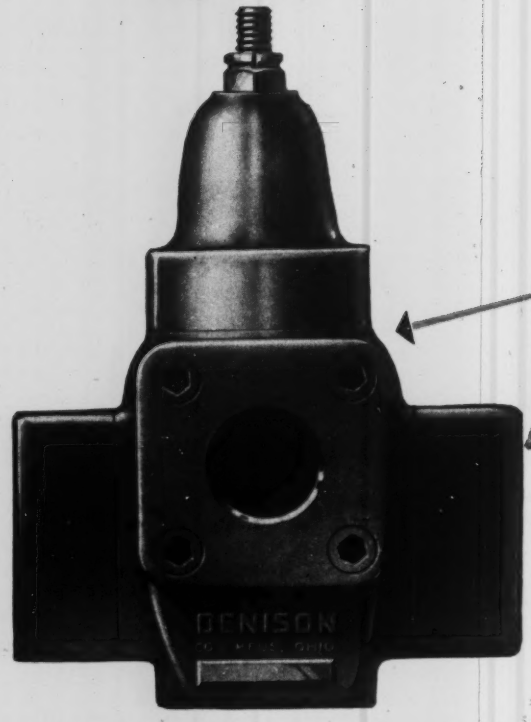
Ask your Westinghouse representative for the details on how Life-Line gearmotors pay for themselves in production time saved. For descriptive literature, write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-07313-A

YOU CAN BE SURE...IF IT'S

Westinghouse







New

DENISON *Direct-Operating* PRESSURE CONTROLS

An improved answer to a wide variety of relief, sequence, and unloading valve needs for systems up to 3000 psi. Denison's new direct-operating pressure control valves offer a control range up to 2000 psi, with *interchangeable* spools that are available either with or without a built-in check feature. Their simplified, cartridge-type design makes them unusually rugged, compact, easy to adapt to any circuit arrangement. Simplifies change-over . . . simplifies your inventory problems. 1/2", 3/4", 1 1/4" and 1 1/2" sizes with threaded body, subplate, or flange-type mountings. Write today for Bulletin VDA.

Direct-Operating Pressure Controls are another important step in Denison's continuing expansion of HydrOILic Pumps and Controls to cover all circuit requirements. For more than a quarter-century, Denison's research and development programs have gained higher performance standards for hydraulic equipment, adapting the full advantages of hydraulics to a wider range of needs . . . simplifying the components to provide ruggedness and precise control for today's high-performance systems. As a result Denison HydrOILic Equipment offers *proved* advantages for almost any hydraulic circuit. Write for full details.

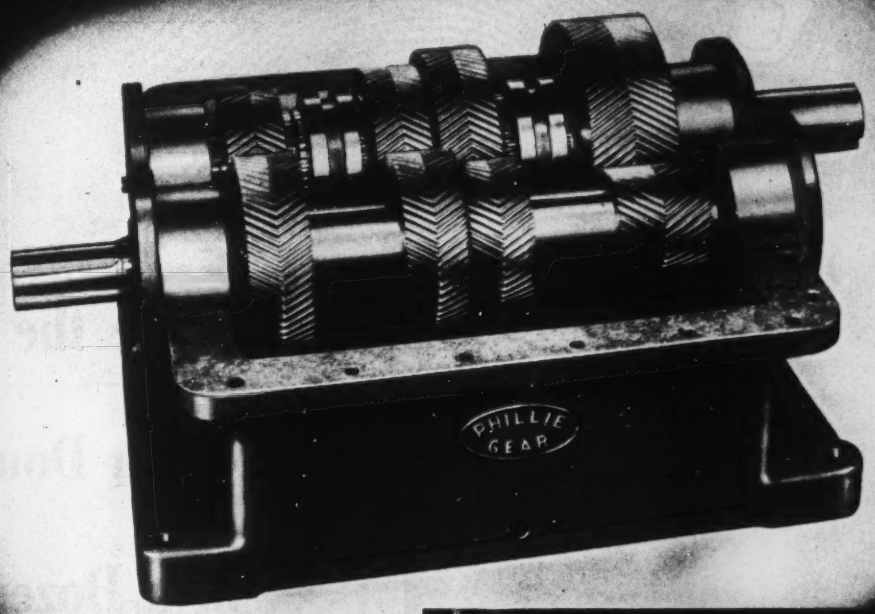
"The Finest Money Can Buy!"

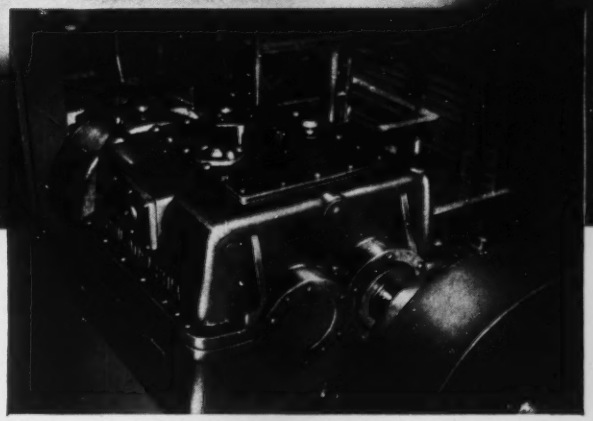
DENISON HydrOILics

The DENISON Engineering Co.
1189 Dublin Rd. Columbus 16, Ohio

STANDARDIZED CONSTRUCTION

. . . to give you Greatest Economy





Based on long experience in building Change-Speed Units to individual specifications, Philadelphia has developed a line of *standardized* units. This cuts the high cost and delayed deliveries of former methods.

Units are positive geared drives using herringbone gears throughout. No belts to wear or slip. Ratios are definite for speed increasing or reduction or in combination. Wide range of horsepowers in 2, 3 and 4 speed units.

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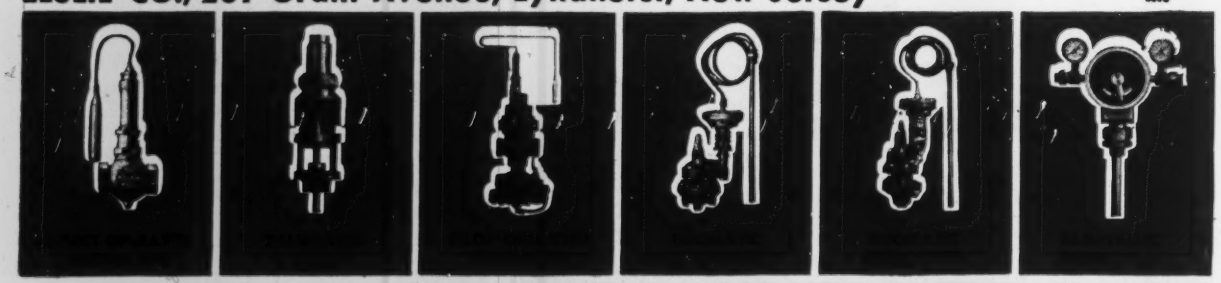

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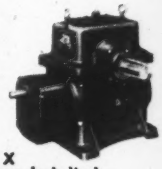
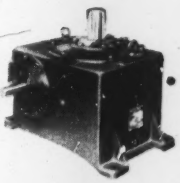
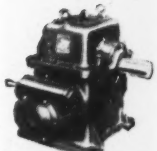
Horizontal right angle worm gear drive. Ratios up to 71 to 1. Cap. up to 266 h.p.



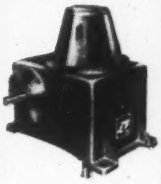
TYPE X
Right angle helical — worm gear drive. Ratios up to 196 to 1. Cap. up to 71 h.p.

TYPE V
Vertical right angle drive, output shaft up, down, or both. Ratios up to 4108 to 1. Cap. up to 216 h.p.





TYPE D
Horizontal double worm gear drive. Ratios up to 4108 to 1. Output torque to 253,000 in. pounds.



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Hytop vertical right angle drive for long, unsupported output shaft extensions. Same ratio and capacity range as TYPE V.

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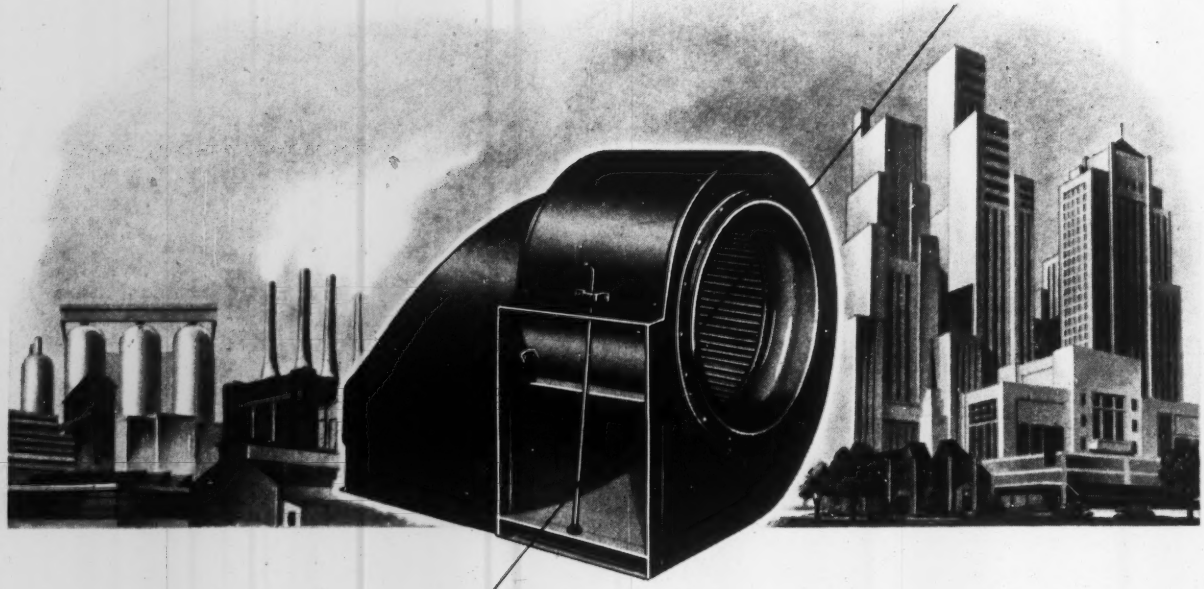

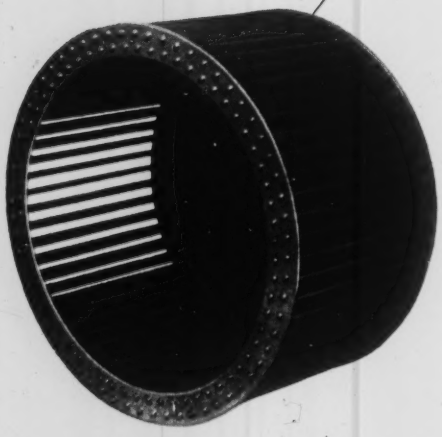

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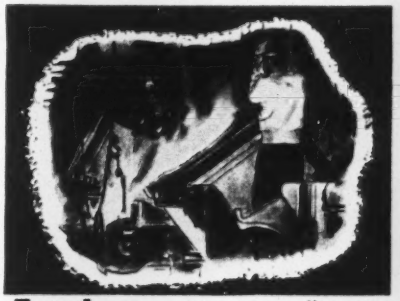

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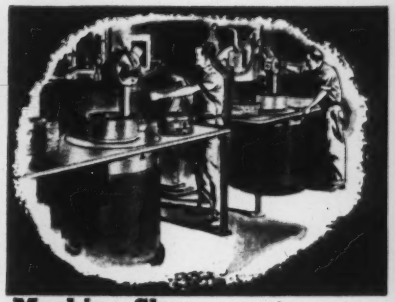

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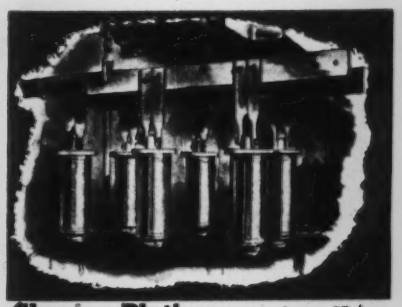

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KOPPERS manufactures piston rings in every size, of every type, for every conceivable purpose. Koppers has the solution to every ring problem, whether in gasoline or diesel engines, compressors, hydraulic presses, steam locomotives or any other industrial or aircraft applications.

Koppers engineering, research and manufacturing facilities are responsible for recent important piston ring developments, K-Iron® and Porous Chrome*. K-Iron is a high-grade, closely-controlled material that imparts superior wear properties to piston rings and is surface treated chemically as an anti-scuffing aid.

Koppers Porous Chrome Rings hold and distribute oil during the break-in, quickly wear to best possible seating, *cut cylinder wear up to 50%, last up to 4 times as long as ordinary rings!*

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- Vertical and horizontal amplifiers flat to d.c., 10% down at 100 KC
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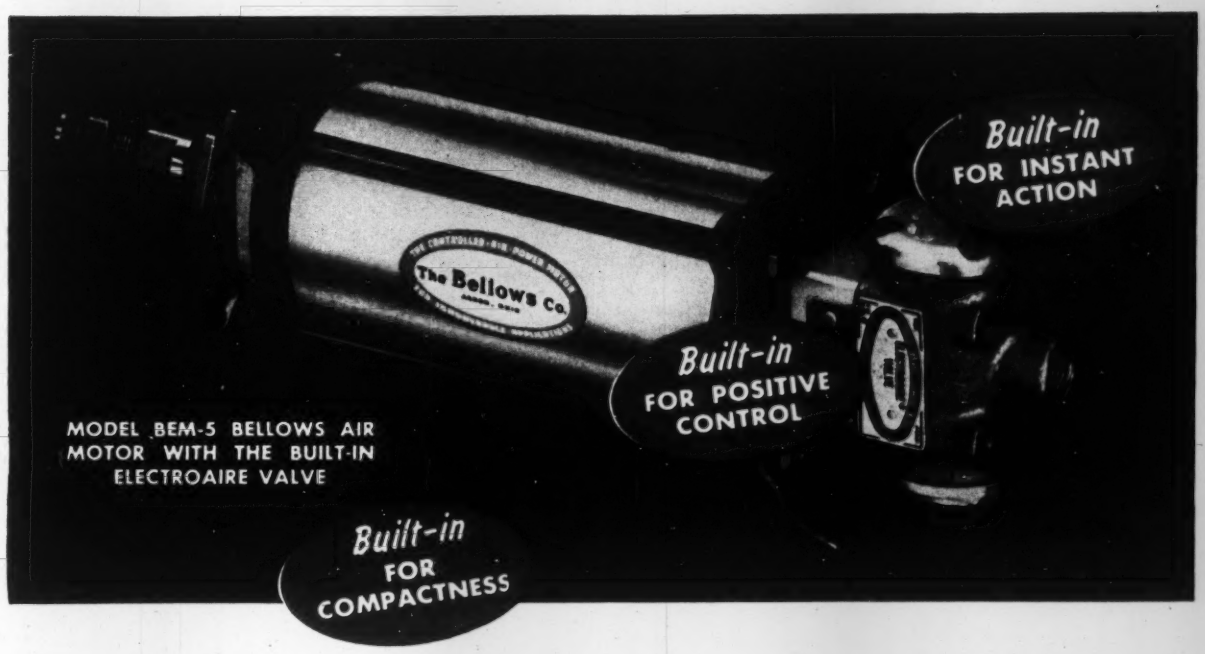

MODEL BEM-5 BELLOWS AIR MOTOR WITH THE BUILT-IN ELECTROAIRE VALVE

In pneumatics operation the more remote the valve from the cylinder the greater the possibility of erratic cylinder performance. In the Bellows Air Motor the valve is integral with the cylinder. This integral construction means *instant* action. No lag, no time delay, no air flow restriction. Integral construction means *positive control.* Directional control . . . speed control. Integral construction means *compactness.* Space saving design . . . simplified installation in cramped quarters, or on moving machine elements.

Bellows Air Motors are made in five bore sizes: 1¼", 1¾", 2½", 3⅜" and 4½". Any stroke length. They are available with either the built-in Bellows manually operated valve, or the Bellows Electroaire Valve*, a low-voltage electrically controlled air operated valve hardly bigger than a package of cigarettes, yet guaranteed for life against solenoid burnout.

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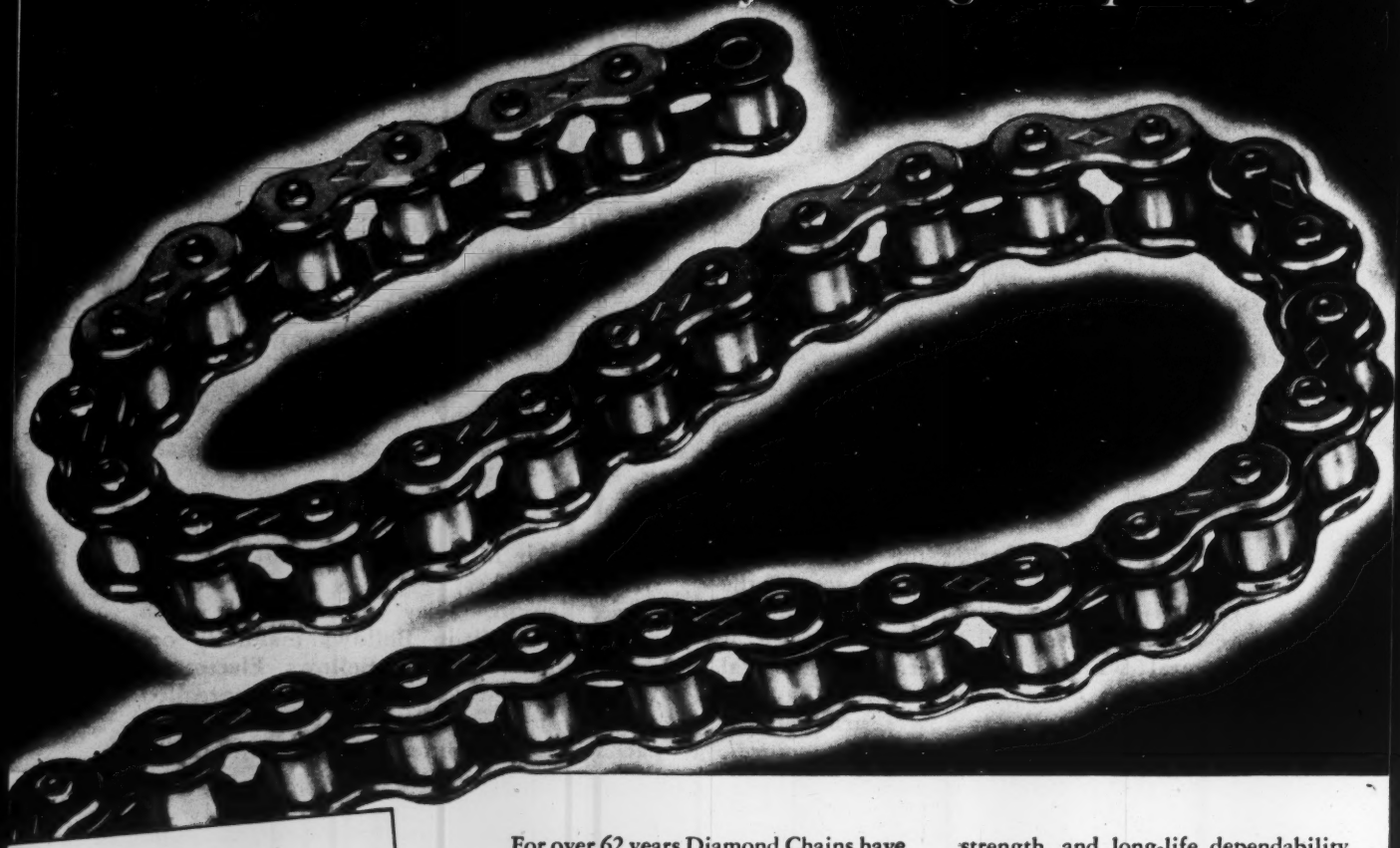

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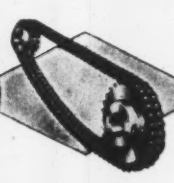
DIAMOND  **ROLLER CHAINS**

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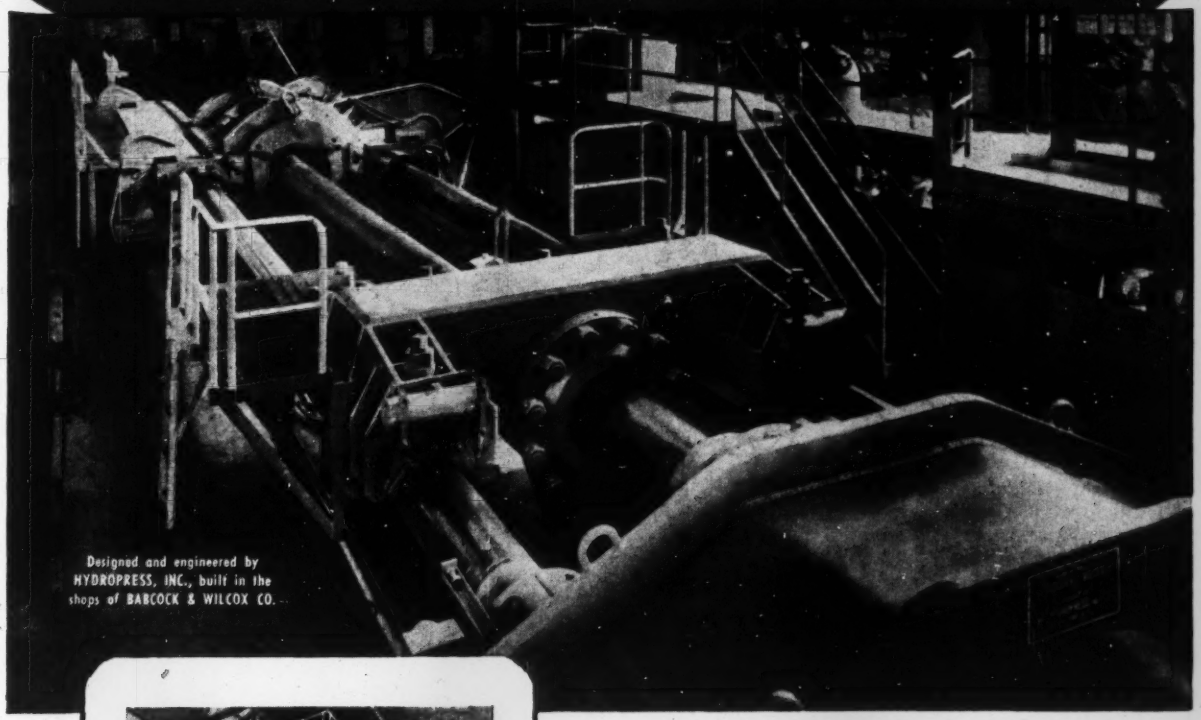
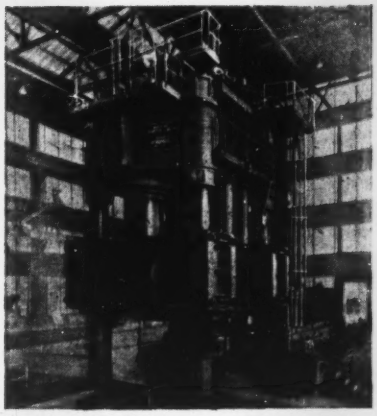


Designed and engineered by HYDROPRESS, INC., built in the shops of BABCOCK & WILCOX CO.



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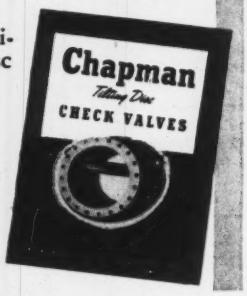
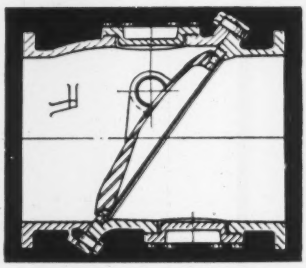
Exclusive TILTING DISC *Check Valve*

Nothing can "unseat" the disc-ring of this valve from its *drop-tight* contact with the body-ring . . . because clearance at the hinge-pins means that this contact is *complete*. There is no sliding action, consequently no wear, no leakage. And the pivoted disc is cushioned to an easy, silent closing . . . without slam . . . in installations that don't have unusual piping arrangements.

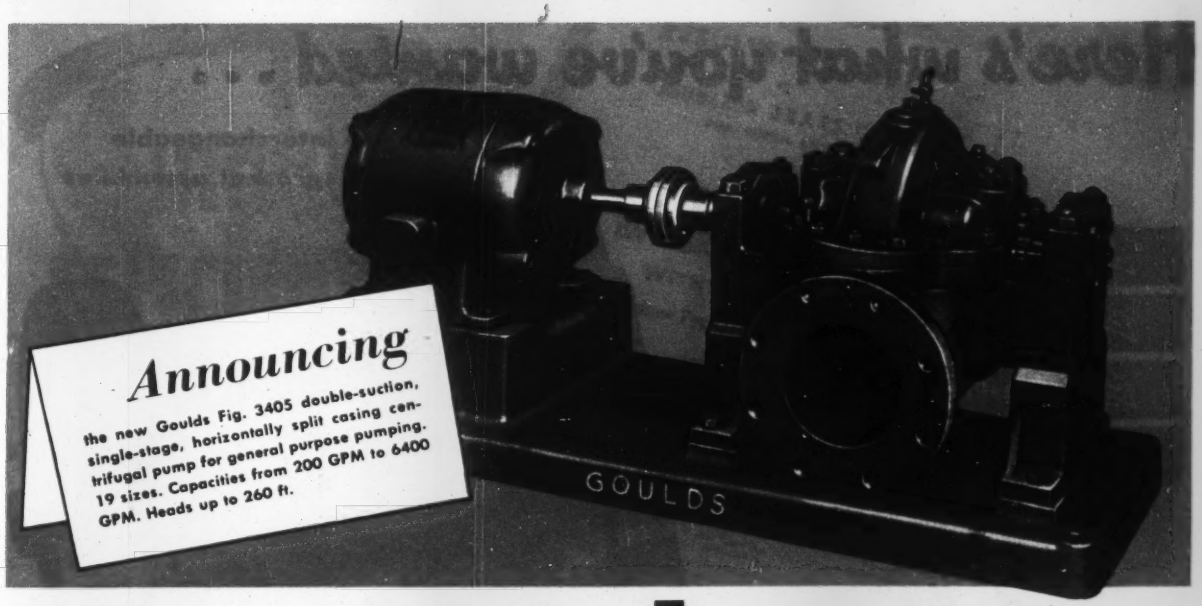
What's more, hydraulic laboratory tests at a top engineering school prove that the specially designed disc and streamlined valve-body reduce head loss as much as 80% under conventional swing-type check valves. See the graphs of these tests . . . and illustrations of the unique construction features of Chapman Tilting Disc Check Valves . . . in Catalog No. 30 (yours for the asking). *Write.*





Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

THE CHAPMAN VALVE MFG. CO.
INDIAN ORCHARD, MASSACHUSETTS


Announcing
the new Goulds Fig. 3405 double-suction, single-stage, horizontally split casing centrifugal pump for general purpose pumping. 19 sizes. Capacities from 200 GPM to 6400 GPM. Heads up to 260 ft.
GOULDS

This new pump gives you 5 big cost advantages

The price you pay is only one element of the cost of a pump installation.

Good engineering practice also figures in the cost of pump breakdowns, low operating efficiency, change-overs to meet new conditions, replacement parts inventories, even the floor space the installation takes up.

Here's why the new Goulds centrifugal pump is designed to improve your cost experience in every one of those elements.

1. ***It combines seven design features that mean maximum operating efficiency and minimum maintenance.***

Every one of these construction features is standard with this new design. Together they offer you, without extra cost, a quality of service that's unique in its approach to general liquid handling.

a. Renewable stuffing box bushings.
b. Bearing housings sealed against moisture and dirt.
c. Cowl-type glands suitable for use with quenching liquids.
d. Stainless steel impeller keys.
e. Teflon water seal rings.
f. Die-formed stuffing box packing.
g. Corrosion resistant gland bolts.

2. ***Interchangeability of parts.***

With only three shaft and rotating parts assemblies to provide for 19 pump sizes and 38 pump combinations, this new design offers you a remarkable range of interchangeable parts. A glance at the interchangeability chart on page 7 of the descriptive bulletin will show you:

a. how this design gives you great flexibility in making field changes should your pumping requirements change;
b. why the first cost of this unit is so low due to standardization in manufacture; and
c. how this interchangeability helps to reduce spare parts inventories.

3. ***Compact construction.***

You will be particularly pleased with the short over-all length of this new design. Short bearing spans cut lengths as much as 50%. This means a real saving in floor space.

4. ***Flexibility of stuffing box.***

You can use either conventional stuffing boxes or mechanical seals depending on requirements. And you can change from one to the other in the field if need be.

5. ***Easy rotation change.***

A unique device, locking shaft seals, permits you to change from right-hand rotation to left-hand rotation or vice versa in the field without construction changes.

More than 50 years of experience in meeting industry's needs for general purpose centrifugal pumps come to a climax in this design.

GET FULL DETAILS **This 12-page illustrated bulletin, No. 721.6, covers the complete details of the new Goulds Fig. 3405, including specifications, interchangeability tables and performance curves. Be sure you have the whole cost-advantage story before you select another general purpose pump. Contact your nearest Goulds representative or mail the coupon below today.**

GOULDS PUMPS, INC., Dept. ME, Seneca Falls, N.Y.

Please send me Bulletin No. 721.6 describing the new Fig. 3405 centrifugal pump.

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in interchangeable sprocket assemblies

- Better Design
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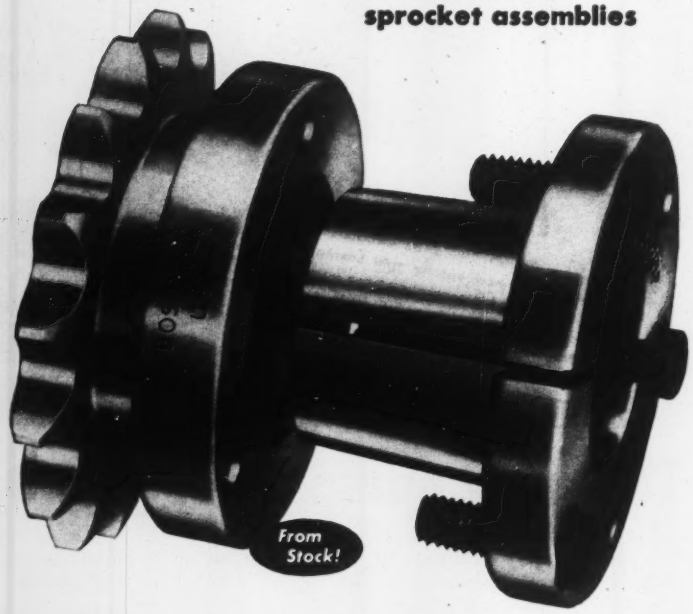
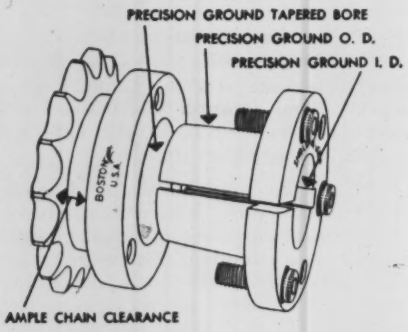


The New SHOLD-A-GRIP®

INTERCHANGEABLE TAPERED BUSHINGS



Accomodates MORE Sprocket Sizes

In the SHOLD-A-GRIP Sprocket, holes for fastening set screws are in the shoulder. Thus, no metal is cut from the sprocket itself. This assures maximum strength, and permits cutting a minimum number of teeth with a maximum size bore. SHOLD-A-GRIP Sprocket Pinions can be fitted to a wider range of shaft sizes — from ½" to 2½" — easily and quickly with SHOLD-A-GRIP Bushings.

Permits Use of SMALLER Sprocket Pinions

The unique shoulder construction brings smaller sprockets into the interchangeable class. For example, Sprocket BKSD ¾" Pitch with 10 teeth can be used on any size shaft from ½" to 1" by inserting the correct size SHOLD-A-GRIP Bushing.

Gripping Power Exceeds Chain Strength

PRECISION-GRINDING of tapered bore of SHOLD-A-GRIP Sprocket, and of inside and outside diameters of SHOLD-A-GRIP Bushing assures:

1 Equalized gripping power the entire length of bushing (even if shaft is not to size).

2 Maximum gripping power. Tests show CHAIN WILL BREAK before SHOLD-A-GRIP will SLIP.

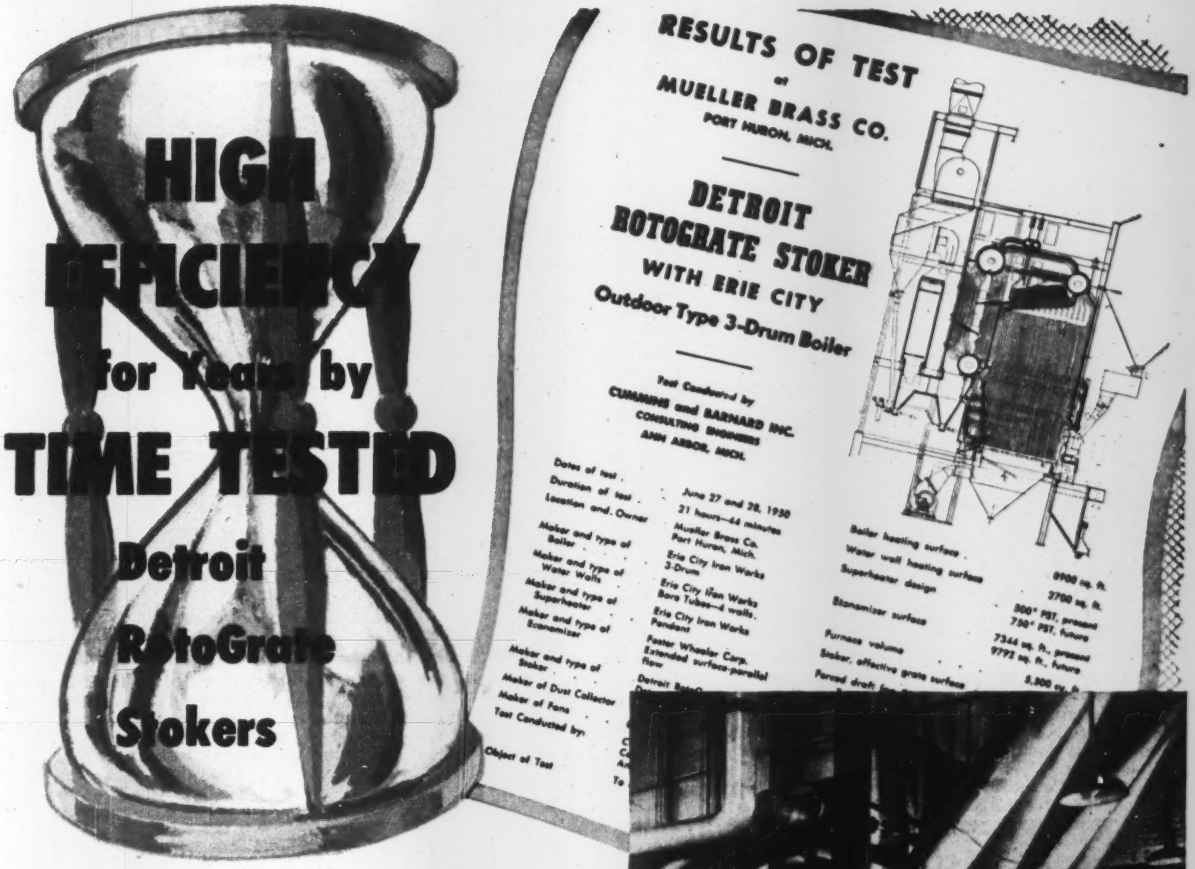
Look over the SHOLD-A-GRIP, and see why it is your best buy. Get complete details...ask your BOSTON Gear Distributor, or write for the new SHOLD-A-GRIP folder. Boston Gear Works, 66 Hayward St., Quincy 71, Mass.

OFF-THE-SHELF DELIVERY FROM STOCK AT YOUR NEARBY BOSTON GEAR DISTRIBUTOR

BOSTON Gear

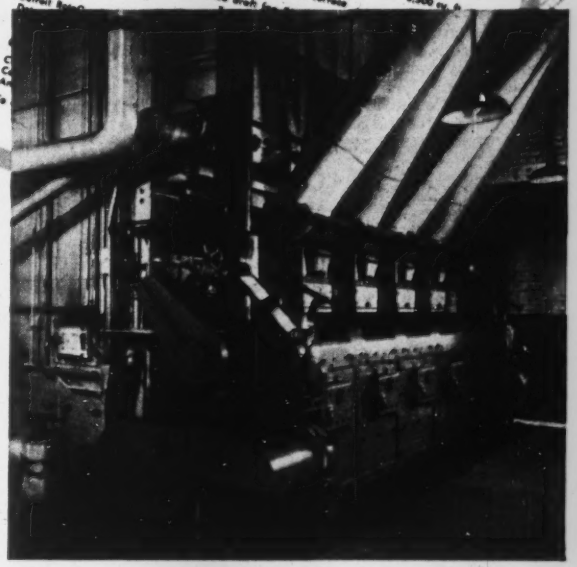
POWER TRANSMISSION PRODUCTS

OVER 8000 STOCK ITEMS



Results of tests of the Mueller Brass new steam generating unit by the consultants were most gratifying. They are typical of Detroit RotoGrate Stoker performance.

Especially important to you as a buyer is the *test of time.* Performance records of the RotoGrates in hundreds of plants—show high overall thermal efficiency, high availability and extremely low maintenance with all grades of coal.



Detroit RotoGrate Stoker applied to the 110,000 pound unit at Mueller Brass Co., Port Huron, Mich.

Write for Detroit RotoGrate Bulletin

There is a Type and Size Detroit Stoker for Every Industrial Need

Detroit Stoker Company

How would YOU solve these 2 problems?

1. IN SOFTBALL MANUFACTURE the most troublesome problem was to obtain absolute uniformity in the kapok cores. These determined hardness, density and shape of the finished balls. H. Harwood & Sons, Inc., of Natick, Mass. solved this problem by molding the cores under hydraulic pressure at closely controlled high temperature. Two inexpensive THERMOSWITCH units per mold provide the needed temperature control at low cost.

2. TAKING THE STRETCH and shrink out of Nylon fish line posed a big problem. It can only be done under high heat. One manufacturer was quoted $18,000 for complicated control equipment. Instead — and very successfully — he stretches the line in a heated die, temperature-controlled by a Fenwal THERMOSWITCH. Cost, less than $25!

3. THIS IS IT — the Fenwal THERMOSWITCH control is simple — compact shell contracts or expands *instantly* with temperature changes, opening or closing electrical contacts. Adjustable and highly resistant to shock and vibration. Fenwal THERMOSWITCH units are solving temperature control problems and improving production throughout all industry.

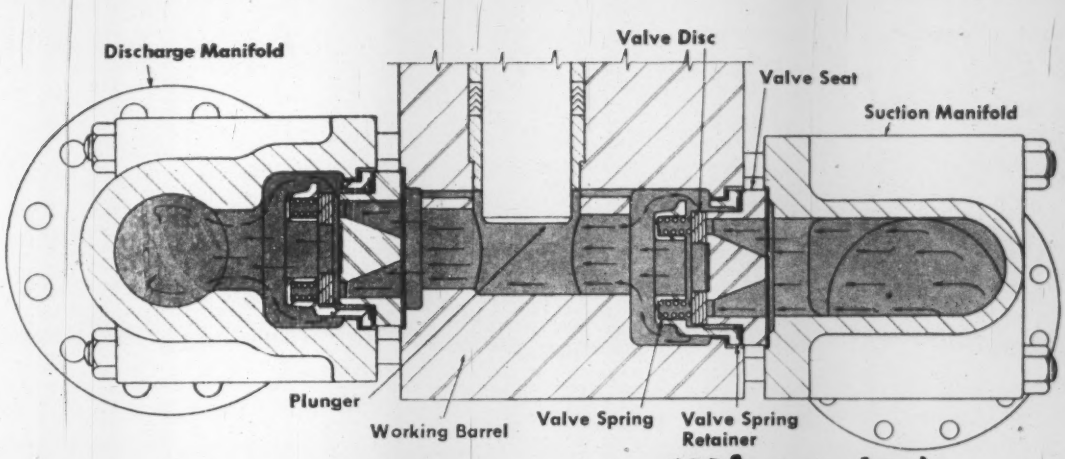
4. SEND FOR THIS NEW CATALOG for complete explanation of the unique THERMOSWITCH unit. Also ask for more detailed, illustrated discussions of the problems above. Fenwal engineers will be glad to help you solve your temperature control problems involving heat, humidity, radiant heat, pressure and other variables. Write **Fenwal Incorporated, 52 Pleasant Street, Ashland, Massachusetts.**

Fenwal

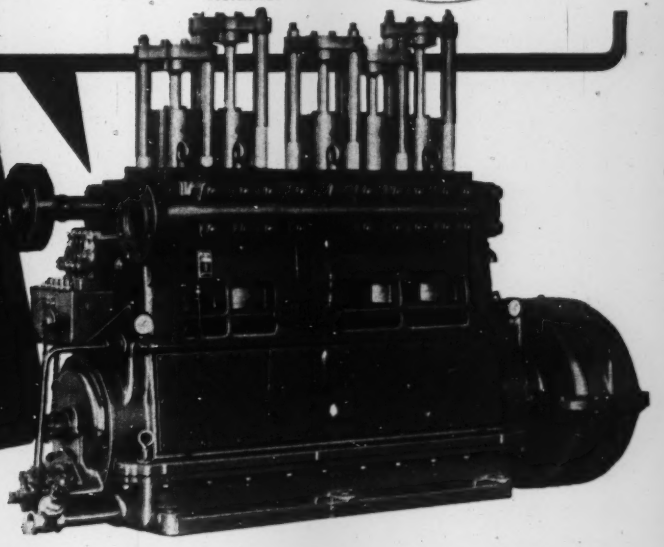
THERMOSWITCH®

Electric Temperature Control and Detection Devices

SENSITIVE . . . *but only to heat*



ENGINEERS: Check these points of Aldrich Direct Flow Design



Aldrich engineers eliminated two right-angle turns in the fluid-end. Now, liquid passes from suction to discharge manifold in a *straight line.* That gave the Direct Flow Pump its name, and set up a whole new concept of pumps, pumping, and pump maintenance. It all adds up as follows:

☐ **Increased operating speeds**—you get whatever volume and pressure you need *from a smaller, lighter, more compact pump.*

☐ **Sectionalized construction**—parts can be replaced at a fraction of the cost of a new fluid-end; also, parts can be made of stainless, bronze, Monel or other special materials—extremely important for corrosive fluid service.

☐ **Maintenance made easier**—no more tapered bores in the working barrel. Manifolds are *not* taken off but slide out on studs—affording room to *lift out* valves as complete units. Packing is easily renewed—note accessibility of stuffing boxes.

☐ **Interchangeable wearing parts**—available among 3, 5, 7 and 9 plunger pumps of same stroke size. This minimizes spare parts costs and inventories.

☐ **Changeable plunger sizes**—in many cases it is only necessary to add new plungers, glands, throat bushings and packing *to the same fluid-end.*

☐ **Drive direct**—by connection to synchronous engine type motor or internal combustion engine; also with integral speed reducer or V-belts.

Contact your Aldrich Representative . . . or write to us direct for complete details on 3", 5" or 6" stroke units.

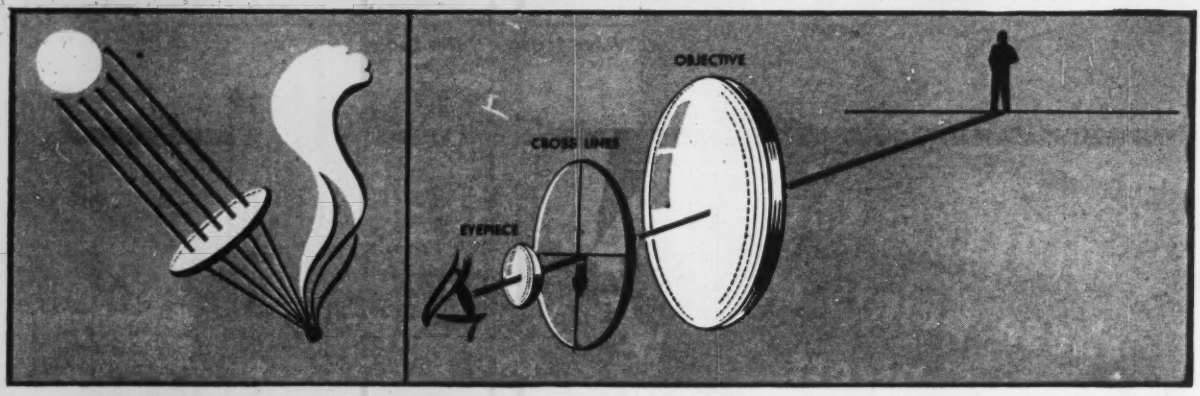
THE ALDRICH PUMP COMPANY

29 PINE STREET • ALLENTOWN, PENNSYLVANIA

...Originators of the Direct Flow Pump

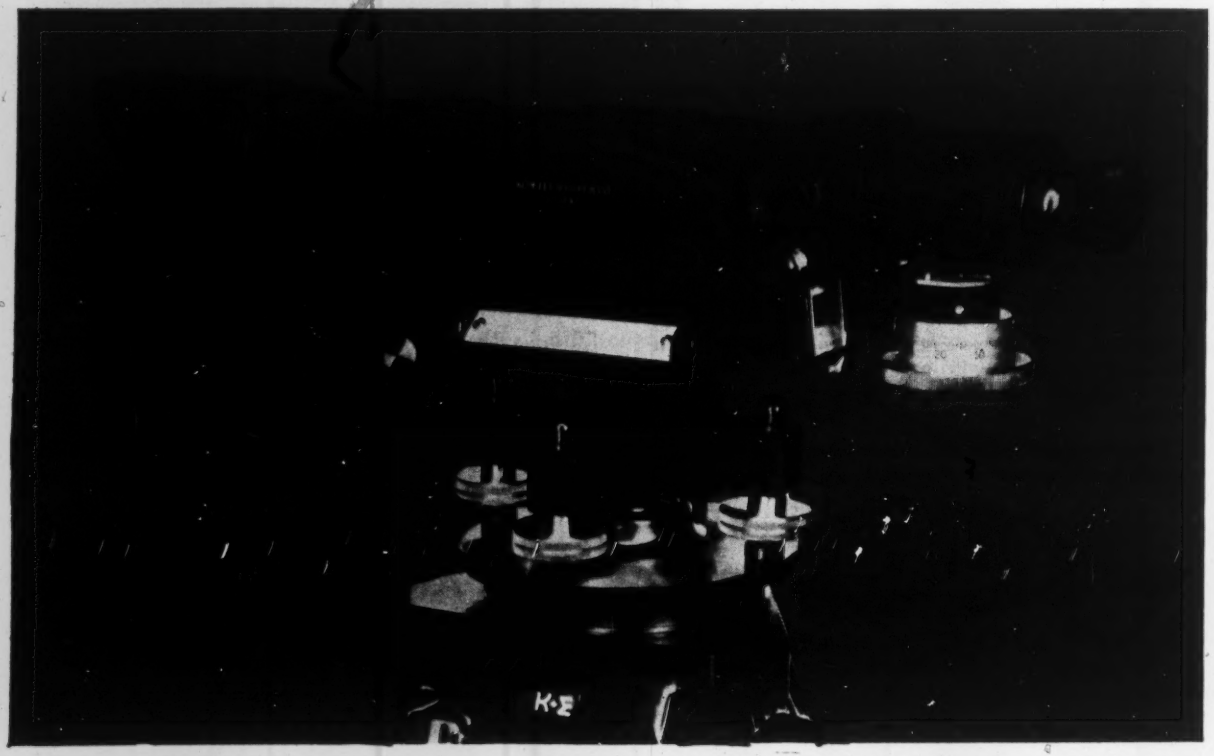
Representatives: Birmingham • Bolivar, N. Y. • Boston • Buffalo • Chicago • Cincinnati • Cleveland • Denver • Detroit
Duluth • Houston • Jacksonville • Los Angeles • New York • Omaha • Philadelphia • Pittsburgh • Portland, Ore.
Richmond, Va. • St. Louis • San Francisco • Seattle • Spokane, Wash. • Syracuse • Tulsa • Export Dept.: 751 Drexel Building, Phila. 6, Pa.

How the image you see gets PARAGON



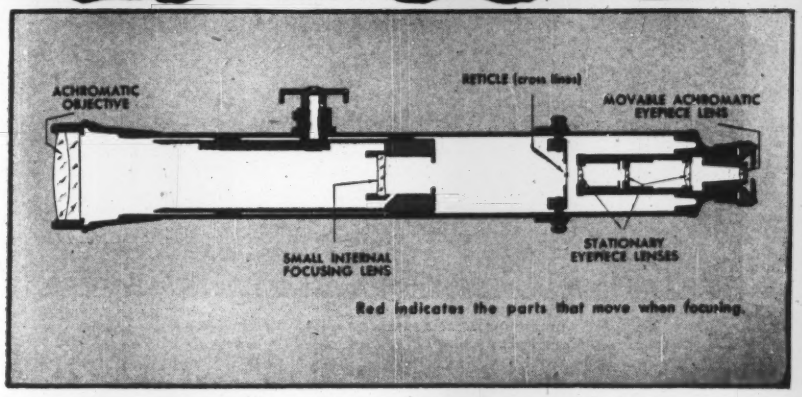
Even an ordinary reading glass can produce an image of sorts. That happens when the sun's rays are focused on a piece of paper as shown. All the rays passing through the lens concentrate at approximately one point where they form a small inverted picture or image of the sun.

By means of a lens, rays from any object at a distance can be made to concentrate inside a telescope in the same way. They form a tiny inverted picture of the object. If a screen like the ground glass of a camera were placed there and viewed through a magnifying glass, the actual picture of the distant object could be seen clearly. The lens that brings the tiny picture into a telescope is called the objective, and the small but powerful microscope that brings it out of the telescope into the eye is called the eyepiece.



into and out of a Telescope

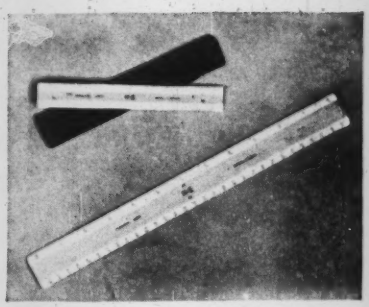
The Right Angle


ACHROMATIC OBJECTIVE
RETICLE (cross lines)
MOVABLE ACHROMATIC EYEPIECE LENS
SMALL INTERNAL FOCUSING LENS
STATIONARY EYEPIECE LENSES
Red indicates the parts that move when focusing.

Cross lines so fine as to be almost invisible can be placed inside the instrument at exactly the place where the miniature picture is formed. Then the eyepiece will greatly magnify not only the picture but the cross lines as well so that both are seen together. Basically, that is the principle of the telescopes used in K&E PARAGON surveying instruments and K&E optical tooling equipment. These contain additional refinements, such as a movable internal lens for focusing and extra lenses in the eyepiece that invert the picture a second time, so that the eye sees it right side up.

Naturally, the above description is extremely elementary. In fine telescopes, such as those made by K&E, every optical part must be made with surpassing accuracy so that the rays of light are not scattered. It is for this reason that K&E designs, grinds and polishes its lenses with an accuracy measured in millionths of an inch. The result is superior definition with unusual contrast and brightness. Minute detail can be clearly distinguished, and cross lines appear jet black.

These are the exacting standards to which K&E builds instruments for engineers, surveyors and builders, as well as optical tooling equipment. The latter makes possible the application of surveying methods to manufacturing and construction problems involving high-precision positioning and alignment. Already these techniques have revolutionized tooling in the aircraft industry and are being adopted in other fields. Ask your K&E Distributor or Branch for details on what these superlative instruments can do for you.



Measuring scales are in constant use on every drawing board. For high quality and accuracy, use K&E PARAGON engine divided scales. They are made of the highest grade boxwood with scale faces of white plastic, permanently cemented. The graduations are filled with dense black pigment for high visibility against the white background.

There is a K&E graph sheet for almost every purpose. In a selection of 300 forms you can find graph sheets for plotting scientific data, forms for sketching and drawing, both mechanical and architectural, or for surveying and mapping. Also, business and financial forms of all types. All are on high quality drawing paper and on the finest tracing paper.

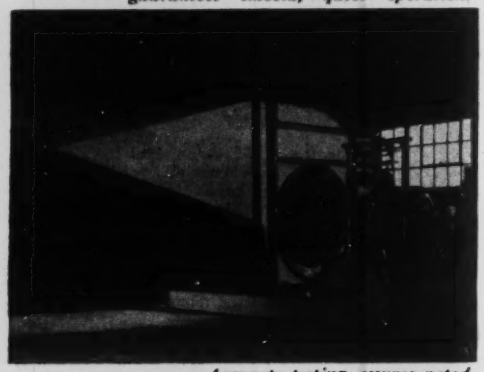
K+E

KEUFFEL & ESSER CO.

Why it costs more to build "Buffalo" FANS

"Buffalo" vacuum pit for test-spinning rotors. Extremely low vacuum in pit enables rotors to be spun at high speeds to ultimate destruction.

Dynamic balance of "Buffalo" fan wheels guarantees smooth, quiet operation.



Accurate testing assures rated performance of "Buffalo" Fans.

As many readers of this advertisement know, "Buffalo" was the first manufacturer of air moving equipment to treat air engineering as a serious scientific subject, worthy of continuous study. With the publication, in 1914, of "Fan Engineering," now in its Fifth Edition, Buffalo Forge Company paved the way for the tremendous expansion in all forms of air handling, conditioning and cleaning, which we now accept as common-place.

We have never deviated, for one year, from the ideals which led to "Fan Engineering" in 1914. We are still interested basically in the "Q" Factor.* This means the building of the best possible product.

This policy has cost us some business in the past, and no doubt will in the future. It has, however, earned us a reputation for fine performance over long periods of years, and has enabled our company to sell many of the finest and most outstanding installations in industry and commerce.

When you buy "Buffalo" Fans, Air Cleaning or Conditioning Equipment, you can be sure that you are getting the best that seventy-five years of experience can produce.

Engineering Sales Representatives in all principal cities are anxious to work with you.

* The "Q" Factor—The built-in Quality which provides trouble-free satisfaction and long life.

75

FIRST FOR FANS

"Buffalo" BUFFALO FORGE COMPANY

148 MORTIMER ST. BUFFALO, NEW YORK

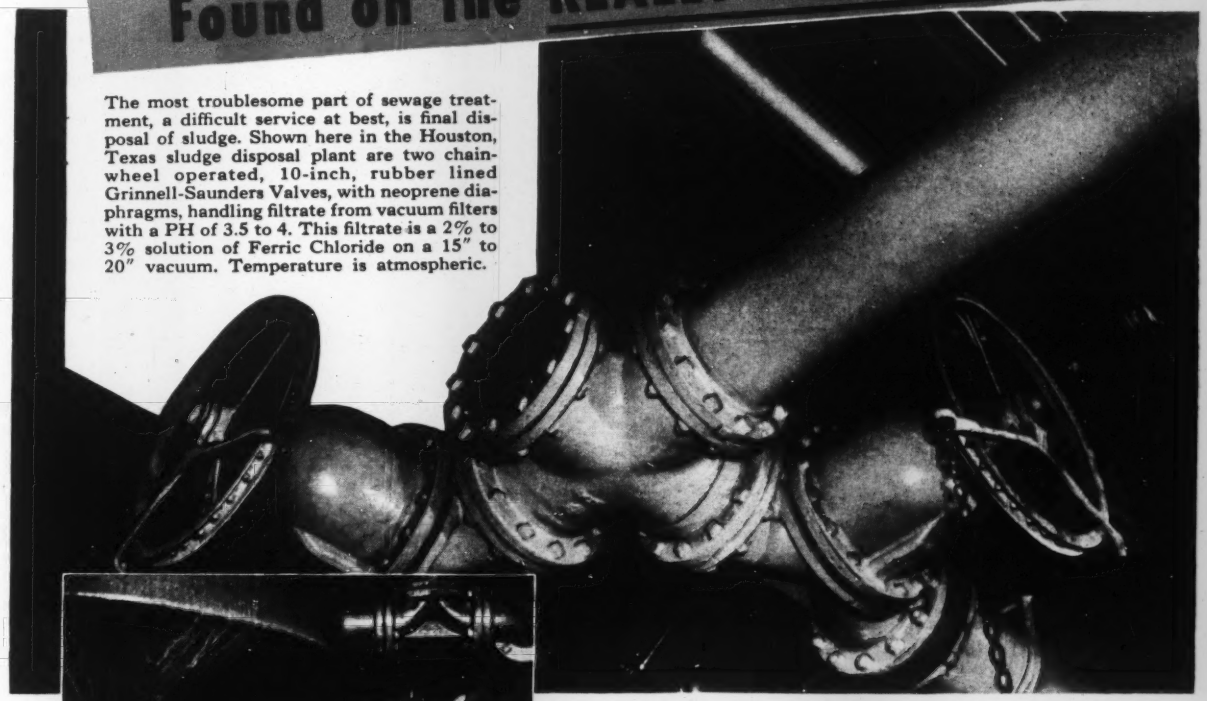
PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

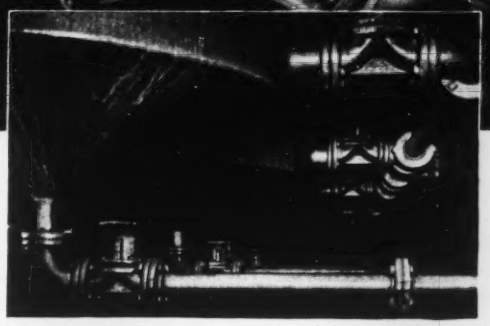
Canadian Blower & Forge Co., Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

VENTILATING	PRESSURE BLOWING AIR CLEANING	COOLING AIR TEMPERING	HEATING INDUCED DRAFT	FORCED DRAFT EXHAUSTING

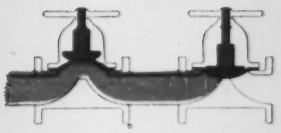
Found on the REALLY TOUGH JOBS

The most troublesome part of sewage treatment, a difficult service at best, is final disposal of sludge. Shown here in the Houston, Texas sludge disposal plant are two chain-wheel operated, 10-inch, rubber lined Grinnell-Saunders Valves, with neoprene diaphragms, handling filtrate from vacuum filters with a PH of 3.5 to 4. This filtrate is a 2% to 3% solution of Ferric Chloride on a 15" to 20" vacuum. Temperature is atmospheric.





◀ In same plant. Eight 3-inch rubber lined Grinnell-Saunders Diaphragm Valves, handling 8% to 10% Ferric Chloride, at atmospheric temperature



OPEN CLOSED

GRINNELL-SAUNDERS DIAPHRAGM VALVES

Streamlined flow. Smooth, streamlined passage, without pockets, prevents trapping of solids. Frictional resistance is at a minimum — regardless of direction of fluid flow. No disc holder in fluid stream.

Leak-tight closure against grit, scale, suspended solids. The resilient diaphragm, plus the large area of contact, gives leak-tight closure against pressure or vacuum.

Working parts absolutely isolated from fluid. Diaphragm completely seals off working parts from fluid in the line. No sticking, clogging or corroding of working parts Valve lubricant cannot contaminate fluids.

Body, lining and diaphragm materials to meet service condition. Bodies stocked in cast iron, malleable iron, stainless steel, bronze and aluminum; other materials on special orders. Valve bodies lined with lead, glass, natural rubber or neoprene. Diaphragm materials of natural rubber or synthetics.

Minimum maintenance. No refacing or reseating is required. No packing glands to demand attention. New diaphragm can be inserted without removing valve body from the line.

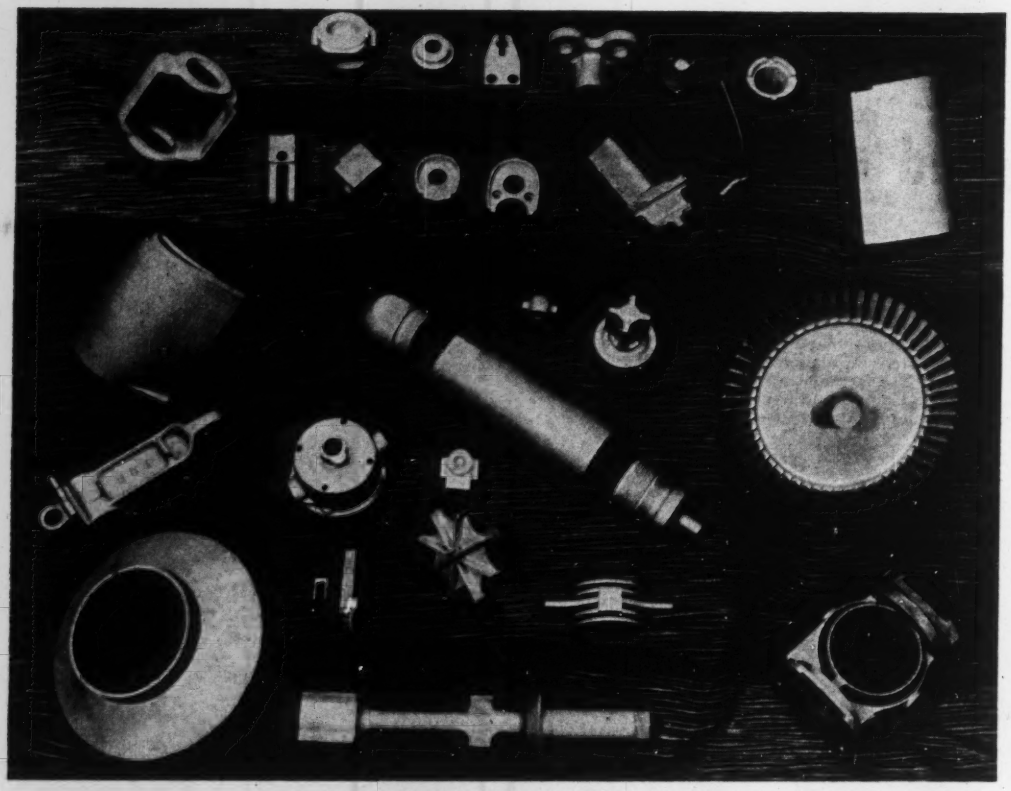
GRINNELL

WHENEVER PIPING IS INVOLVED

Write for Grinnell-Saunders Diaphragm Valve Catalog

Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems



Inco-Cast precision investment castings offer a practical way to make a wide variety of difficult-to-machine shapes including: thin vanes, wing sections, non-critical gear teeth, slots and threads.

How you can save up to 50%... on small parts

With Inco-Cast precision investment castings, others are saving as much as 50 percent of the production cost on small parts.

Perhaps you can, too. If you need small parts with complex internal sections, shallow blind holes, unmachinable cavities or other shapes that are costly to make, it may pay you to investigate precision casting. For precision casting lends itself to economical production of intricate shapes where tolerances as close as .005" per linear inch are needed.

Inco-Cast precision castings not only save you money—they make it possible for you to use extra strong and harder alloys for longer service life...

- You can reduce your machine shop bottleneck because they require little or no machining.
- They make possible the use of hard-to-machine metals.
- In many applications you can get parts made by precision casting that would be impossible to make by other methods.
- Frequently it's even possible to simplify your designs when you use precision castings.

If you have a problem with a part whose cost of production seems out of line — if it's a shape where a single casting might eliminate many machining operations — if you have a design that cannot be worked out economically — just send a blueprint or actual sample with an estimate of the quantity needed.

Inco casting specialists will analyze your problem and, if precision casting is a practical solution, they will give you an estimate of costs and their suggestion on the best alloy to use.

In the meantime, for more detailed information about this money-saving process, write for your free copy of "Investment Casting—Its Advantages and Practical Applications."

The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

SOME ALLOYS PRECISION CAST BY INCO

Nickel-Base Alloys
Ferrous Alloys
Austenitic Stainless Steels
Martensitic Stainless Steels
Ferritic Stainless Steels
Carbon Steels
Alloy Steels
Tool Steels
Cobalt-Base Alloys

Inco Castings PRECISION, SAND, CENTRIFUGAL

INCO TRADE MARK

MECHANICAL ENGINEERING

Published by The American Society of Mechanical Engineers

VOLUME 75 NUMBER 2

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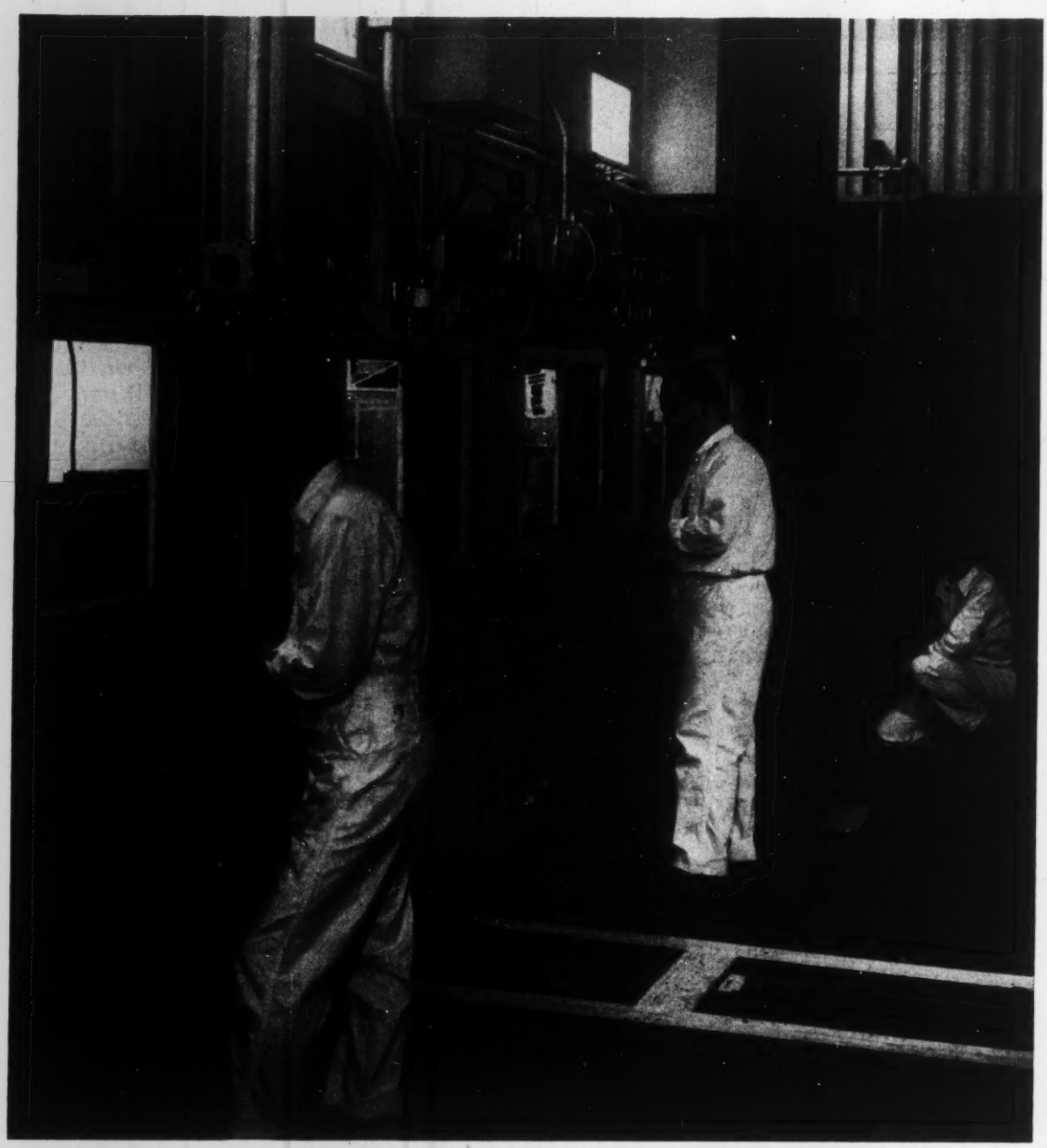

Looking Into "Cave" of Mound Atomic Laboratory

(Scientists manipulate laboratory apparatus inside the "cave" at Mound Laboratory, Miamisburg, Ohio, the Atomic Energy Commission's first completely permanent installation and operated for the Commission by Monsanto Chemical Company. The remote-control operation protects researchers from radioactivity. Experiments are being performed beyond the double glass windows especially designed to bar harmful rays. The windows which are filled with liquid are actually two feet thick. Work at Mound which can be disclosed includes such functions as nuclear studies, construction and maintenance of special equipment, biological research, health physics, and waste disposal.)

VOLUME 75
No. 2

MECHANICAL ENGINEERING

FEBRUARY
1953

GEORGE A. STETSON, *Editor*

Air-Pollution Controls

SOUND progress toward the solution of the vexing and nationwide problem of the control of air pollution will be hailed by engineers and the public alike as a significant contribution of engineering to the welfare of mankind and the advancement of industrial civilization. Hence the announcement made in August, that The American Society of Mechanical Engineers had appointed a full-time executive secretary to administer the activities of its Committee on Air-Pollution Controls and had set up a program and established a number of subcommittees, has raised hopes that a determined and large-scale attack on the problem will soon be able to report tangible results.

The Committee and its executive secretary, Frederick S. Mallette, have been busily at work. It is reported that the Subcommittee on Current Projects and Trends has met with a splendid response. The replies to its questionnaires are being analyzed and prepared for publication. The individuals, organizations, companies, and utilities which provide material for the subcommittee's studies will not be identified in the report, and hence there should be no reluctance on the part of any of them in providing the information requested. The report will indicate what research projects are under way in the field of air-pollution control.

It will be recalled that the proposed objectives of the ASME Committee on Air Pollution Controls, in part, are to initiate and co-ordinate research concerning the health, comfort, nuisance, engineering, and economic aspects of the problem; to collaborate in the formulation and publication of standards of appropriate nature; and to encourage and assist in the preparation, presentation, and publication of papers on the many phases of atmospheric pollution.

The comprehensive seven-point program of the Committee is being carried out by a number of subcommittees on Current Projects and Trends, Health and Industrial Requirements, Economics of Air-Pollution Control, Fuels and Fuel-Burning Equipment, Co-ordination and Promotion of Research, and Instruments and Measurements.

In co-operation with the ASME Fuels and Power Divisions, the Committee on Air-Pollution Controls organized a program of brief papers, educational in nature, for presentation at the 1952 ASME Annual Meeting. At the session devoted to this subject, planned as a panel of experts in various phases of air pollution, were such topics as: Recent developments and progress in air-pollution abatement; health aspects; air pollution indicated by symptoms on vegetation; legal aspects of air-pollution abatement; stack diffusion; engineering and management; sampling and measurement; and industrial experiences in fly-ash collections. The size of the attendance at this session and the intense interest shown in the many discussions indicate the importance that engineers attach to the subject of air-pollution control.

Recent reported increases in the death rate of the City of London during unusually dense and long-continued periods of foggy weather give an added impetus to the program of the ASME Committee and emphasize the broad incidence of the problem in metropolitan and industrial areas. The skills and knowledge of many branches of science and engineering are involved in study of the problems of air-pollution controls. Effective and adequate solutions will depend on a high degree of co-operation and intelligent analysis.

Certificate of Qualification

AT A recent meeting of one of the state boards of registration for professional engineers and land surveyors, 49 applications for licenses to practice professional engineering within that state were under consideration. Of the 49 applicants, 19 were already registered in other states. Had these 19 applicants held certificates of qualification from the National Bureau of Engineering Registration, it is probable that they would have been granted their licenses immediately. As it was, each application had to be held up until the board, starting from scratch, could check the references and educational institutions named in it. For this service an additional charge had to be levied against each applicant.

The reverse of this experience is found in the case of an engineer who held a certificate of qualification issued by the National Bureau of Registration. A change in his position made it necessary for him to hold licenses to practice professional engineering on a nationwide basis. On the basis of the certificate he received licenses from 31 state boards almost by return mail.

Certificates of qualification are issued by the National Bureau of Engineering Registration which is operated by the National Council of State Boards of Engineering Examiners. An information pamphlet issued by the Registration Bureau states that the Bureau "is a fact-finding and certifying agency, acting as a clearing house for state registration authorities and as a reliable source of verified information regarding the professional records of engineers. It does not legally register anyone and does not grant any authority or issue any license or registration, this being the proper function of state

boards only. All state boards of engineering registration reserve the right to take whatever action they deem necessary to conform with the requirements of their laws and regulations in connection with any application for registration within their state." However, all except a few member boards of NCSBEE have specifically stated that they will accept such certification.

The certificate of qualification was established "to minimize the effort and expense of registered engineers desiring to secure registration or license in more than one state." An applicant for a certificate must submit on a form provided by the Bureau his complete record (education, engineering experience, legal registration, membership in engineering or scientific societies, and references as to character and experience). This application is submitted by the Bureau to the registration board in the state of which the applicant is a resident or in which he is practicing. When in the opinion of the state board the applicant is so entitled, his certificate of qualification is endorsed by them and the Bureau then makes "an independent investigation of every item in this record and will either verify each one or indicate on the record the items which have not been verified, with reasons." The fee for verification and certification, including one photocopy of completed verified professional record, certificate of qualification, and state-board endorsement, is $35, additional copies $2 each. For an additional fee varying from $5 to $15, the original certificate will be brought up to date at any time upon request.

The NCSBEE Committee on National Bureau of Registration consists of nine members with an advisory board of representatives of the American Society of Civil Engineers, The American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Chemical Engineers, National Society of Professional Engineers, American Society for Engineering Education, American Association of Engineers, and American Railway Engineering Association. The report of this committee presented at the thirty-first annual meeting of the NCSBEE in September, 1952, stated that during the period from July 1, 1951, to June 30, 1952, 79 new applications for certificates of qualification had been accepted, with 25 pending from the previous year. Of this total, 89 were approved, 8 were rejected, and 7 were pending on June 30. As of June 30, 1952, the total number of certificates of qualification issued by the Registration Bureau was 1397. As of June, 1952, the total number of registrants in all states was 185,966 (176,533 engineers and 9433 land surveyors) and the total number of "nonresident" engineers was 28,294. Further information may be obtained by writing to the National Bureau of Engineering Registration, P. O. Drawer 1404, Columbia, S. C.

Cincinnati Training Program

PROGRESS in the implementation, in the Cincinnati area, of the Training Program of Engineers' Council for Professional Development is being watched with keen interest by engineers and educators who have entertained high hopes for its success. The decision of ECPD to put the program into effect in the Cincinnati area was based on the interest displayed in the program by educational institutions, industries, employers, and engineering societies of that area, which includes Cincinnati, Hamilton, and Middletown, Ohio. In that area, with an estimated population of 1,250,000, there are about 10,000 engineers, of which 3700 are members of local sections of national engineering societies, and about 500 employers of engineers.

The reasons for the training program being put into effect in Cincinnati are well known. For many years it has been recognized that the most difficult period in the development of an engineer occurs during the years immediately after his graduation.

There are, it is true, many fortunate young engineers who pass from their school days into engineering and industrial organizations which have training programs. But such training programs are not to be found in every company, in every industry, or in every community. Where they are not found, the individual must create his own program of self-development.

Several years ago the Engineers' Council for Professional Development, through its Training Committee, made an intensive study of the problems which the graduate engineer faces and issued a report which proposed a training program for communities where conditions are favorable for the co-ordinated efforts of employers, educational institutions, and local engineering societies to assist young engineers to continue their education and professional development and to become useful members of the communities in which they live.

In the few months since the decision to put the training program into effect in the Cincinnati area was taken, important organizational steps have been initiated. A sponsoring group met in October to learn about the program from A. C. Monteith who was chairman of the ECPD Training Committee which devised the plan. This group decided that the program was desirable and assigned representatives to a local committee. The local committee, which will be responsible for putting various phases of the plan into action, has held several meetings. Representatives of local industries on the committee have set up a three-point program and are at work on one phase of it—determination of needs for continued education programs. The University of Cincinnati has completed a new study of administrative problems associated with graduate study programs in engineering. Several professional-development committees of the Engineering Society of Cincinnati are being tied in to the ECPD activity. The Technical and Scientific Societies Council, a co-ordinating body of local-section representatives is considering possible recognition each year, on its "Engineer of the Year" award program, of several young men who have exhibited outstanding professional development in their "first five years." Local sections of the constituent bodies of ECPD and of other national groups are being brought into action. All in all it looks as though Cincinnati were getting ready to show other industrial communities how to make the most out of the engineering graduates who live and work in that community.

High-Pressure INSTRUMENTATION

Some Recent Advances and Probable Extensions in the Art

By P. W. BRIDGMAN

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LEGENDS CONCERNING HIGH PRESSURES

DOUBTLESS there are numerous reasons why the high-pressure field has not been cultivated more extensively. Some of the reasons are good and some not so good. In past years there were almost fantastic legends about the discouraging and strange properties of matter under the action of high pressure, some of these legends mutually contradictory. Thus there was the legend that water was absolutely incompressible and could be forced through the pores of solid metal by sufficiently high pressure. This legend goes back to the days of the Florentine Academy and the first attempts to detect the compressibility of water, and persisted to at least the time of Amagat, who thought that he had forced mercury through the pores of a solid steel casting with a pressure of 3000 atm. The cynical modern explanation is that Amagat's casting had flaws in it, and that the tinsmith of the Florentine Academy did not justify his probable reputation for perfect craftsmanship.

This legend of the penetration of solid matter by a high-pressure liquid has another form in the stories of tightly stoppered bottles lowered into the sea and pulled up again full of water. The conclusion was drawn that the water must have been pushed through the solid glass walls, because the stopper showed no evidence of damage. Anyone who has witnessed the dramatic shrinkage of a cork under a hydrostatic pressure of only a few atmospheres knows the answer to that one. On the other side, legend has it that the pressures in the depths of the ocean are so utterly inconceivable that only a few miles down the sea water has been compressed by the stupendous pressure to the density of steel, so that all the steel vessels that have ever sunk are floating forever at this depth, buoyed up by the dense liquid.

ACTUAL DIFFICULTIES

Legend aside, there are certain difficulties peculiar to the high-pressure field and the fact that these were not at once surmounted played its part in the slow development of the field.

In the first place there is the fact that at pressures at all high the subject of experiment has to be enclosed in a heavy pressure vessel which precludes direct observation and demands some indirect and perhaps unnatural method of measurement. Difficulties of this sort can usually be surmounted with sufficient ingenuity, particularly now that any desired number of electrically insulated leads can be got into the pressure chamber. It is, however, still not unusual to encounter skepticism about the results of a pressure experiment because of the unperspicuousness of the apparatus, and I have often been asked how I can be sure that the high-pressure "ices," for example, are really solids.

Another difficulty is in the smallness of many of the effects under those pressures which can be reached with the simple apparatus of the conventional laboratory or shop. The scientific development of our subject may be said to have begun about 150 years ago with the proof by Canton that water was measurably compressible. Canton used in his proof the great magnification afforded by piezometers constructed on the pattern of overgrown thermometers. Although Canton proved the existence of a compressibility, his numerical value was in error by a factor of 4. One method of avoiding the error due to the smallness of many pressure effects was to make them larger by increasing the pressure. Here at once technical difficulties were encountered, in great part due to leak. So greatly were the difficulties arising from leak esteemed that it was hailed as a great and imaginative forward step in technique when Perkins generated pressures of 100 atm by lowering his apparatus with a rope into the sea.

The difficulty of correctly measuring compressibilities as small as that of ordinary liquids was further increased by the distortion which the containing vessels universally experience under the action of pressure. Two sorts of improvement were necessary before this difficulty could be surmounted. The theory of elasticity was not sufficiently understood, so that serious mistakes were made in calculating the corrections for distortion. For instance, as eminent a physicist as Jamin, of interferometer fame, did not understand that a hollow vessel of homogeneous material exposed to uniform hydrostatic pressure on its entire external and internal surface experiences a uniform shrinkage just as if it were part of a single solid piece. The other difficulty was that materials were not sufficiently uniform and homogeneous, but were full of flaws and strains, so that their deformation when exposed to hydrostatic pressure was far from uniform. It was not until the introduction of the Bessemer process of making steel plates that one could count on a piece of steel shrinking uniformly in every direction under a hydrostatic pressure, a property which enters essentially into our present methods of measuring the compressibility of solids.

NEW HORIZONS

By now these various difficulties have so far been met that I think we are in a position to accept the challenge of measuring any physical property of materials up to about 30,000 atm at room temperature. To exceed these limits other problems must be solved to which I would now like to invite the reader's attention. It is paradoxical that one of the greatest difficulties which at first opposed our entry into the high-pressure field, namely, leak of the transmitting liquid, disappears at pressures above 30,000. The simple reason is that there are no more liquids above that pressure (with only one or two inconsequential exceptions), all liquids having been frozen solid by the pressure. The problem of leak is replaced by a new problem, namely, to find some solid which remains sufficiently soft at such high pressures to transmit stress approximately hydrostatically. The solution of this problem does not appear hopeless, and I have already used silver chloride with considerable success in measuring the electrical resistance of metals up to 100,000 atm. The discovery of a suitable transmitting

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medium is demanded all the more if one is to penetrate into the very inviting unexplored field of high pressure and really low temperature. Some work is already under way looking in this direction.

The supreme problem in pushing pressure to the limit is the strength of the containing vessel. The most natural method of solving this problem is to use stronger materials, something which of course will be done as soon as the materials are available. Already such an improvement in material has occurred at least twice in the history of our subject, first in the development of high-strength alloy steels with tensile strengths in the neighborhood of 350,000 psi, and second in the development of carboloy. Carboloy has a compressive strength nearly twice that of steel, and furthermore, under the action of pressure, loses its brittleness in tension and also becomes stronger in tension than steel. It is carboloy that has made possible my experiments to 100,000 atm or even higher. It appears at present that we cannot anticipate much improvement over the performance of carboloy as a material for high-pressure construction; even the diamond would probably be not more than 50 per cent better.

THE "CASCADING" PROCESS

It would seem to me that ultimately we must come to some sort of cascading process in the construction of our pressure vessels, that is, a nest of pressure vessels, with progressive increase of pressure from the outside in. Theoretically there is no limit to the pressures that can be reached in this way. The supreme example is afforded by nature itself, for the mammoth pressures in the sun and stars are built up by a cascading process. At the same time nature shows us the chief difficulty limiting practical use of the cascading process, namely, the difficulty of controlling and knowing what is happening in the inner members of the nest—it does need an astronomer to remind us that we know nothing directly of the interior of the stars, which are accessible to us only by calculation. In the laboratory I have applied one stage in the cascading process, but have not been able to proceed to the next step. Progress here evidently awaits a bright idea.

Pressures inside a cascaded apparatus may be either static or dynamic. Perhaps we shall eventually be able to control a static cascaded pressure, as in the stars, but I believe that for at least the immediate future we are going to get our new highest pressures dynamically, probably with explosives. Progress already is being made in this direction. It is evident that the method will be complicated and expensive, and that good numerical values are going to be hard to obtain. Probably, at least in the beginning, these numerical values will have to lean heavily on extrapolations from the region of controllable static pressure.

PHENOMENA AT HIGHER PRESSURES

What now are some of the phenomena which we can anticipate will make the new field of higher pressures interesting? First and foremost there are the phenomena of the electronic breakdown of the atoms which we are pretty confident occurs in the interior of the stars. Here the breakdown is in all probability complete, but at lower pressures, such as we can hope to reach in the laboratory, the breakdown will doubtless occur in stages. In fact, at least two cases are now known in which it is highly probable that a rearrangement of the electronic shells in the atom has been forced by pressure. When one considers the very great complication of the electronic structure of most atoms, one may anticipate a tremendous amount of detail in the process of complete atomic breakdown, so that the domain of pressures above 100,000 atm, say, may well exhibit a wealth of phenomena greater than shown by ordinary matter in the domain now accessible to us.

At pressures less extreme than required for atomic disintegration there are, I believe, a number of inviting prospects. It is now possible to combine pressures up to 50,000 atm and temperatures to 2000 or 3000 C. I cannot but believe that it will be possible to create many new substances under such conditions. In a range of less extreme temperatures the whole field of the properties of alloys under pressure is almost untouched. Thus I have very recently found that a pressure of 25,000 atm will produce an intermetallic compound of tin and bismuth. Under ordinary conditions the system bismuth-tin is a simple eutectic system with no intermetallic phases.

The possibility must always be kept in mind that new phases may be produced irreversibly if pressure can be raised high enough to push the substance over an intermediate hill of potential. An example of this is the conversion of ordinary yellow phosphorus into black phosphorus. We may anticipate instances of a similar effect on a less drastic scale. I have recently found examples. It is usually said that ordinary materials are perfectly elastic to hydrostatic pressure, and that any permanent change of density after exposure to hydrostatic pressure is evidence of internal flaws which are closed by the pressure. If, however, various sorts of glass are exposed to pressures above something in the neighborhood of 50,000 atm, permanent changes of density of several per cent may be produced. On reflection this does not appear so strange, for the x-ray analysis of glass shows that the structure is not close-packed, but there are cavities on the atomic scale which offer the potentiality of rearrangement under pressures sufficiently high. It is now my opinion that, short of atomic breakdown, the only substances which are perfectly elastic under indefinitely high hydrostatic pressure are the perfect crystal lattices. It will be interesting to examine whether the plastics show permanent increases of density above some critical pressure, as do some of the glasses.

Another high-pressure field awaiting development is connected with the very great increases in plasticity of the metals produced by pressure, with enhancement of such physical properties as strength under the great cold-working permitted by the great plasticity imparted by pressure. For example, it is indicated that if a steel wire could be drawn through a die while completely immersed in a liquid under high hydrostatic pressure, increases of strength of the order of twice that ordinarily obtainable may be anticipated. The technique of wire-drawing under such pressures evidently offers difficulties, but there is no reason to think the difficulties are insurmountable.

SOME ASPECTS OF MEASURING HIGH PRESSURES

Finally, I should like to consider a few aspects of the problem of measuring pressure. The broad classification of pressure-measuring devices into primary and secondary is convenient and corresponds to laboratory practice. The primary pressure gage determines pressure by referring directly to the definition of pressure as force per unit area. The most usual forms of the primary gage are the mercury column and the dead-weight piston. In spite of the directness of measurement by these two primary gages neither is entirely free from correction; the mercury column must be corrected for temperature variations and the compressibility of the mercury, and the free-piston gage for distortion of piston or cylinder by the pressure under measurement. These corrections are under good control, so that primary measurement of pressure is capable of high precision.

It is perhaps worth mentioning that in principle there is at least one other method of finding the absolute pressure than by the use of a primary gage. This is by the use of the for-

mulas of thermodynamics. Not all thermodynamic formulas in which pressure appears are capable of such use. For instance, the identical relation between the so-called "pressure coefficient," thermal expansion, and compressibility is one from which the dimension of pressure cancels from both sides of the equation, leaving nothing to set the standard of pressure. But there are other formulas in which there is a single term involving pressure connected by the equation with other terms into the measurement of which pressure does not enter. Any such equation in principle permits the determination of pressure, in that the unit of pressure must be so adjusted that the equation is satisfied. An example is the conventional expression for the Joule-Thomson coefficient, connecting the change of temperature with pressure at constant total heat to volume, specific heat, and thermal expansion. Other examples are the pressure coefficient of electromotive force of a cell, or the pressure coefficient of surface tension. I do not know whether the practical difficulties are so great as to preclude use of this theoretical possibility or not. It is at least obvious that use over any extensive pressure range would demand an integration for those substances whose coefficients vary appreciably with pressure.

An eventual problem is pressure measurement in the range above the freezing pressure of available liquids where pressure has to be transmitted by a solid. The simplest method will probably be most successful, namely, measurement of the total thrust on a piston of known area. Errors will be introduced by friction, which now cannot be eliminated by rotation of the piston as is possible when pressure is transmitted by a liquid, and by distortion of the cross section. Friction can be minimized by making the diameter of the piston large compared with the thickness of the solid on which the piston acts and by the use of conical packing rings of minimum thickness to retain the solid. Distortion of the cross section can be determined from the displacement of probes let into fine holes in the wall of the pressure vessel. Pressures determined in this way will be used to locate various fixed points in the high-pressure domain, such as suitable transition points. There is at present one such fixed point, the transition point of bismuth in the neighborhood of 25,000 atm. By use of the measures just described it should be possible to determine this point to something of the order of 0.1 per cent.

As a secondary measure of pressure any easily measured and reproducible property of matter may be used. The change of electrical resistance of a metal or an alloy is one such, and the manganin resistance gage has had considerable use. The chief difficulties with this gage are failure of complete reproducibility, especially wandering of the zero. These irregularities are due for the most part to internal strains, the effect of which to a large extent may be removed by suitable seasoning procedures. I have found in my work to 30,000 atm that the zero is stabilized much better after exposure to pressure of this magnitude than it is by the lower pressure of 12,000 atm, which was the pressure range of most of my earlier work. For applications in which zero stability is of great importance and in which it is feasible to take unusual precautions to secure constancy of temperature, it probably will pay to use for the secondary resistance gage some soft metal which is incapable of storing as large internal strains as manganin. I have found two specimens of lead of different origin to have the same pressure coefficient of resistance within 0.01 per cent.

Whatever the secondary gage it usually will have to be calibrated, and this calibration under most conditions will be made, not directly against a primary gage, but against some pressure fixed point which has been previously established once and for all against a primary standard. Such fixed points are offered by freezing and melting of various substances, or by polymorphic transitions. Desiderata in such points are sharpness, that is, a unique pressure when approached from either direction, speed of attaining equilibrium, change of volume, or other change accompanying the transition large enough to measure easily, and absence of super- or subheating or pressing. There are not many transitions with all these properties. One convenient such point, which I have made fundamental in most of my work, is the freezing pressure of mercury at 0 C. This point also has been used by others.

FREEZING PRESSURE OF MERCURY

Hitherto I have located the freezing by the change of volume, which amounts to about 5 per cent. This is large enough to be handled without too much difficulty, but one has to keep one's wits about one not to allow the piston displacement to stray outside the range in which both liquid and solid phase are present together. Appreciable quantities of mercury have to be used to give a change of volume large enough to control, and this means that the heat of melting is large enough to demand appreciable times for reaching temperature equilibrium. With my usual setup it was possible to determine a mercury fixed point with a difference of pressure of not more than 1 in 3000 as reached from above and below in a time of 2 hr.

Recently I have found that the determination of the mercury fixed point is much facilitated and accelerated by using as the indicator of the phase change the change of resistance instead of the change of volume. Resistance changes by a factor of fourfold on passing from liquid to solid, contrasted with the 5 per cent change of volume. The mercury may be used in the form of a fine capillary, in which the total heat of freezing is so small that equilibrium is rapidly attained. By making the capillary out of lucite or other plastic one avoids the fracture of the capillary which would accompany freezing if glass were used. In determining the freezing point, one first, by suitable manipulation, freezes about half the mercury, and then by slight changes of pressure, which can be controlled by a 0.0001-in. Ames dial attached to the piston, causes the resistance to drift first in one direction and then in the other. In this way I have located the pressure of freezing within limits beyond the sensitivity of the manganin gage, that is, within limits less than the 1 part in 3000 just mentioned in 10 or 15 min.

"By-Pass" Jet Engine

A NEW type of air engine has been revealed by the partial removal from Britain's secret list of the Rolls Royce Conway. It operates on what is known as the "by-pass system" and is believed to be the first large air engine in which the system has been applied. All performance details on the Conway remain secret.

In a conventional jet engine the whole of the air is compressed and then heated by the admission of burning fuel, expanded through the turbine, and finally ejected at high velocity. In a by-pass engine only a proportion of the air is compressed and heated. The remainder by-passes the combustion system and turbine, and rejoins the heated gases in the jet pipe to mix with them and lower their temperature before the whole mixture is ejected.

This gives a higher propulsive efficiency, and in practice causes a lower fuel consumption for any given thrust.

This type of engine is claimed to have a lower fuel consumption than any simple jet engine yet produced, making it particularly suitable for long-range transport and bomber aircraft.

LARGE-DIAMETER LINE PIPE

Its Production and Some Applications

By W. C. HOPPE

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APPLICATION

PIPE lines are a means of transportation—silent underground arteries carrying petroleum products and natural gas across the nation. Considerable study and planning are applied to the design, engineering, negotiation, construction, and operation of a pipe line, its accompanying distribution and gathering systems and compressor stations. Well-designed pipe lines make it possible to transport large volumes of natural-gas and petrolum products to the various markets all over the country. Thus it is a practical reality for many people to use natural gas in their homes and places of business. Among other things, the cost of heating our homes, driving our automobiles, and traveling by airplane, train, or bus, is much lower than it would be if crude oil and products such as gasoline, fuel oil, and high-octane aviation gasoline all had to be transported by means other than pipe lines. These arteries of gas and oil extend over the nation from the various producing areas, and the continued search for additional sources is opening new fields to maintain an adequate supply for the mounting needs of our economy.

In January, 1950, there were about one-half million miles of pipe for gathering, transmitting, and distributing natural-gas and petroleum products in the United States. Of the total, about two thirds are used for natural gas and one third for petroleum products.

The 24-in. emergency pipe line, known as the "Big Inch," built during World War II, will serve as an example of the transmission capacity of a pipe line. Under normal operating conditions this line transmitted an average of 280,000 bbl of oil per day. By comparison, 1167 tank cars each carrying 240 barrels of oil would be needed every day to deliver an equivalent amount of oil by rail. In addition to the greater terminal facilities that would be required, the actual number of tank cars would be much higher because of the time lapse for movement of the cars and their empty return. A similar 24-in. pipe line would deliver about 230,000,000 cu ft of natural gas per day. A line of this capacity would satisfy less than one third of the gas demand in the Chicago area, which at present has pipe lines bringing in over 800,000,000 cu ft of natural gas every 24 hours.

PRODUCTION

The fabricating process developed by the author's company to produce great quantities of expanded large-diameter steel pipe is fully as interesting as the end use of the pipe. Production of pipe, 8 5/8 to 36 in. diam in lengths of 40 ft, requires efficient material-handling facilities for the constant movement of 90 to 100 pieces per hr. Steel, initially in the form of plates 40 ft long, has been processed at a rate in excess of 50,000 tons per month. The development of the company's process was made possible only with the integration and co-operation of the various engineering and research groups. Constant efforts to improve the product and its manufacture are being carried on by the engineering, research, metallurgy, tool-design, and production departments.

Expanded pipe was developed in 1930 when the competitive market demanded higher operating pressures from the amount of steel being put into a piece of pipe to obtain more economical transmission of gas and oil. Equipment and tools for making flash-welded expanded pipe were designed by the engineering groups, while the metallurgical research group developed the type of steel and procedures to produce the required characteristics in the material. Fast operating tools and dies for forming the plate into pipe, and handling, testing, and finishing equipment were developed to simplify production. All planning was directed toward rapid, economical handling, and maintaining a minimum of change-over time.

Major steps in the manufacturing process include trimming the plate edges preparatory to welding, forming the plate into tubes, flash resistance welding, trimming the weld bead, end-facing and beveling, expanding within bored dies, and testing and inspection.

FABRICATION

In the edge-trimming operation, flattening rolls are utilized to remove any buckles in the plates, Fig. 1. The edge-trimming tools are made of standard high-speed-steel (HHS) tool materials. Carbide tools are not used because the plate may be stopped in the middle of the trimming operation to allow for clearing of subsequent operation stations and such action would break the cutting edge of a carbide tool. Edge trimming consists of cleaning and putting a slight bevel on the two longitudinal edges of the plate for the shop-welding operation.

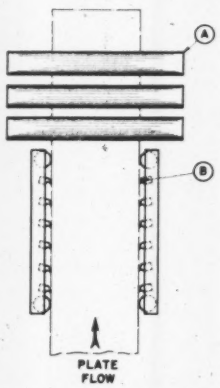

FIG. 1 SCHEMATIC VIEW OF EDGE-TRIMMING OPERATION

(A, Flattening rolls; B, HSS trimming tools. Each tool takes a successively deeper cut.)

Forming the plate into a tube is done in three successive press operations. The first step is to crimp the edges into a shallow U-shape. The second press forms the U into a pear shape. The third operation forms the tube into a round shape and puts sufficient "set" in the steel so that the tube remains round for the flash-welding operation. A set of dies, for each operation, is required for each diameter from 8 5/8 to 36 in. and are 40 ft in length when assembled. The presses used have capacities ranging from 3000 to 11,000 tons.

One of the high lights of the manufacture of large-diameter pipe is the flash-resistance-welding operation. The full length of the pipe is simultaneously welded without the application of any additional metal. By maintaining the proper voltage between lightly touching edges of the formed plate, the flashing expulsion of metal particles takes place and heat is generated to

Contributed by the Production Engineering Division and presented at the Fall Meeting, Chicago, Ill., September 8–11, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

bring these edges to a semifluid state. When uniform heat along the edges is reached, the machine bumps these edges together to make the weld, Fig. 2. A set of welding dies is required for each diameter, ranging from 8⅝ to 36 in., and minor adjustments are made for wall-thickness variations for any one diameter.

Trimming the flash-weld bead is another interesting phase of the operations. Cutting edges to remove the flash consist of a series of single-point tools taking successive cuts as the tool carrier moves along the pipe as can be seen in Fig. 3. Both the inside and outside beads are trimmed at the same time and because of the slow speed, approximately 40 fpm, standard HSS tool materials are used. Incidentally, during the early development of these cutting tools, carbides as used today were unknown, but some readers may recall the German "Widia" from the expression "like a diamond." This carbide insert was brazed to the tool bit in much the same manner as today's carbides. It was first tried in 1930, and new carbides are being tried

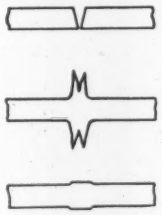

FIG. 2 SCHEMATIC VIEW OF PIPE-WELD CROSS SECTION

(*Top*, edges before welding; *center*, after welding; *bottom*, after trimming.)

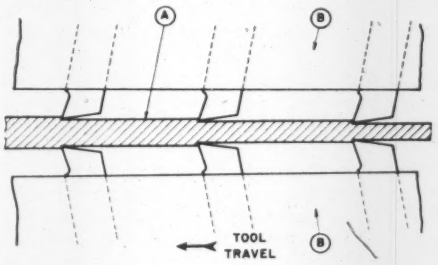

FIG. 3 SCHEMATIC VIEW OF FLASH-TRIMMING OPERATION

(A, Weld area of pipe; B, tool carrier.)

today in much the same manner, but their use seems impractical, since it has not been possible to insure that an insert will not loosen or break and fall off. A broken-off insert may be impressed into the wall of the pipe necessitating scrapping the pipe or a portion thereof. Tool maintenance on this operation is higher than on others and research is continuing to develop better tool life by use of new materials and changes in clearance and rake angles.

In the rough end-facing operation there has been considerable improvement in tool life and surface finish. At present, standard HSS tools which the operators grind to produce a curled chip about 2½ in. diam with a thickness of about 3/32 in., are being used. A new cast-alloy insert is currently being tried which shows promise for further improvement and reduced tool cost.

The final end-facing operation, after the pipe is expanded, assures a bevel and welding lip of the required accuracy for welding purposes in the field. Since the pipe is straight after expanding, the final facing machines are aligned and the pipe is held by clamps while the two cutting tools are rotated—one tool cutting the bevel while the following tool cuts the flat on the lip. A facing machine operates at each end of the pipe and one operator is assigned to each machine. The beveling tool is guided by a roller which follows the inside contour of the pipe, Fig. 4. A cemented-carbide tool is used for the bevel and a very smooth surface is produced, thus giving the quality of end surface and contour desired to make a rapid sound field weld. In both the rough and finish facing operations, hard spots, irregular ends, and the weld are encountered, and for this reason the search continues for better tools along with changes in clearance, rake angles, and cutting speeds. At present the speed for facing with standard HSS tools is about 64 fpm, while for the carbide tools the cutting speed is about 75 fpm.

Maintenance and repair of equipment and tools is a vital part of the program for the manufacture of tubular products. For these machining operations, cemented-carbide tools have been adopted almost exclusively and have effected a considerable

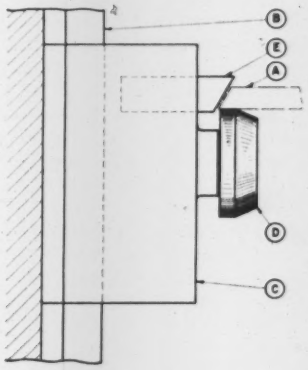

FIG. 4 SCHEMATIC VIEW OF END-BEVELING OPERATION

(A, Stationary pipe; B, rotating carrier; C, floating toolholder, under spring pressure; D, roller guide; E, bevel tool.)

saving in both time and expense. The use and application of these cutting tools is frequently changed in an effort to improve the product and reduce the cost of operations to meet competition.

PIPE EXPANSION

Although only briefly mentioned in the foregoing, the internal expansion of line pipe is one of our most important operations. The expansion of pipe by this method produces several desirable results. A positive test is made of the weld which is far more severe than any condition to which the pipe may later be subjected in normal operation. The pipe is stretched circumferentially approximately 1 to 1¼ per cent. For example, 24-in-diam pipe is stretched ¾ to ⅞ in. circumferentially. Pipe is expanded within cylindrically bored dies, and the result

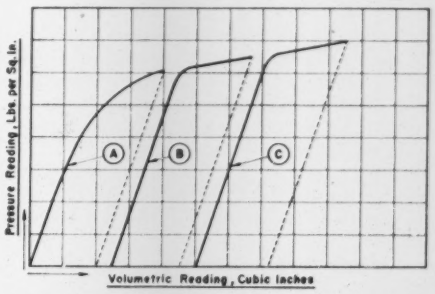

FIG. 5 GRAPHICAL INCREASE IN YIELD STRENGTH BY CONTROLLED INTERNAL PRESSURE APPLICATIONS

(A, Typical curve produced on unexpanded pipe when pressure is applied to expand to size. B, second pressure application on same pipe in excess of previous pressure. C, Third pressure application higher than previously applied on same pipe.)

is a product within the close tolerances for straightness, roundness, and size, so necessary for economical and efficient pipe-line construction. Another result is the increase in circumferential yield strength obtained by stretching the pipe, Fig. 5. A considerable saving can be realized from this increase in yield strength since higher operating pressures can be used on expanded pipe than would be permissible if the pipe were used in the "as-rolled" condition. The steel plate in the as-rolled condition has a yield strength around 44,000 psi. By stretching the pipe, the circumferential yield strength is increased so that a minimum of 52,000 psi can be guaranteed. This increase in yield strength must also be controlled to maintain ductility requirements. Cold-bending of the pipe in the field must be done at intervals to follow the terrain and any length may be selected at random for bending purposes. Therefore it is necessary that a ductility minimum be maintained to meet bending requirements; consequently, excessive stretch producing a yield point too close to the ultimate strength must be avoided.

A simple explanation of the increase obtained in circumferential yield strength of the pipe might be illustrated by a tensile test bar. When the bar is loaded in the test machine to produce a definite elongation or permanent set, the elastic limit is exceeded and a new yield point is established at the point of loading. Further elongation cannot be produced unless a load greater than the initial load is applied. This, of course, must occur below the ultimate strength. Thus, by application of a predetermined pressure to obtain a certain elongation circumferentially, line pipe can be produced within specified yield-strength limits.

To demonstrate the importance of increased yield strength, it is sufficient to inspect code practices and allowable stresses on transmission lines. For cross-country gas-transmission lines, the American Standards Association Code B-31.1 permits operation of a gas line to a maximum of 72 per cent of the specified minimum yield strength, or a maximum of 80 per cent of the hydrostatic test pressure applied to the pipe. The hydrostatic test pressure may not produce a fiber stress in excess of 90 per cent of the minimum specified yield strength. A comparison of expanded pipe with pipe in the as-rolled condition having the same diameter, pressure, and safety factors demonstrates the advantages of expanded pipe. An expanded pipe 26 in. diam having a yield point of 52,000 psi and operating at 700 psi pressure will have to be 0.250 in. thick. An as-rolled pipe 26 in. diam having a yield strength of 44,000 psi and operating at 700 psi pressure will have to be 0.288 in. thick. In terms of thickness this amounts to a difference of 0.038 in., which at first appears insignificant.

For further analysis consider a transmission line 500 miles long. The difference in weight of the two types of pipe is about 27 tons per mile. For 500 miles the difference in weight amounts to about 13,500 tons; and assuming a pipe cost of $120 per ton, a saving of over $1,500,000 is realized by using pipe of the higher yield strength. Thus the use of expanded pipe is a very important factor in keeping the expense of gas transmission down. The same general practice is applied to oil lines and entails similar savings.

QUALITY CONTROL

Quality control is imperative for good line-pipe production. It starts with the plate at the steel mill where a resident inspector checks surface quality, rolling practice, and physical and chemical tests on each heat of steel. During the production of pipe, check inspections of dimensional setups are made at regular intervals on the various operations. At the welding stations inspectors check welding quality and dimensions. Visual inspection by experienced men is made of the entire weld of each length of pipe and those which are satisfactory are stamped with a serial number indicating the welding machine, shift, and pipe number. This makes it possible to identify the pipe at a later date, even after it has been buried in the ground for years.

The final hydrostatic-test operation proves the strength of the pipe and its resistance to shock. Each length of pipe is tested hydrostatically to pressures producing fiber stresses equal to 80 to 90 per cent of the minimum circumferential yield strength. While the pipe is under full test pressure, hammer blows, each roughly equivalent to $6\frac{1}{2}$ ft-lb, are struck directly upon the weld at 2-ft intervals. The purpose of this test is to detect any defective weld which may not have existed prior to this operation. This operation demonstrates the resistance to hydraulic shock and establishes the maximum operating pressure of the pipe line since the code permits the pipe to operate at 80 per cent of the hydrostatic-test pressure.

Immediately after the hydrostatic test, an inspector walks along each length of pipe in the test machine while the pipe is still subjected to 50 per cent of the hydrostatic-test pressure, to check for leakage and apply the hydrostatic-test stamp. Then the pipe is checked for end size by the application of ring gages and snap gages. The ring gage is bored $\frac{3}{32}$ in. over nominal diameter and the snap gage is set for $\frac{1}{32}$ in. under nominal diameter. This assures good matching ends for line-up and welding in the field. It is sufficient to mention that line joints welded in the field are subject to very rigid inspection, including x ray, and ends of proper dimensional quality and surface assure strong sound field welds.

The pipe is given a hot rinse to remove any accumulated oil or grease and another visual inspection is given to the pipe before it is marked and loaded for shipment. During the course of final inspection, test coupons are cut from one of every 100 large-diameter pipe lengths and tested for physical properties and chemical analyses. Selection of these test coupons is made at random and in many cases the selection is made by a representative of the customer. Chemical analyses of the test pipe are made to insure good properties for welding, and the specimens are tested for ultimate strength, yield strength, and ductility in both longitudinal and circumferential directions along with a tensile test of the longitudinal weld.

CONCLUSION

The aggressive application of research, engineering, tool design, metallurgy and production have all contributed to the development and large-scale manufacture of a product which has made the transmission of natural-gas and petroleum products economically feasible, and has reduced their cost to the ultimate consumer, which has some effect on every one of us. The widespread acceptance of this process of manufacture is proved by the production and installation of over 33,000 miles of large-diameter line pipe since 1927.

PLASTIC reinforced with glass fiber is just beginning to come into production, although it has been available for custom use for some time, according to the *Industrial Bulletin* of Arthur D. Little, Inc., for December, 1952. Considerable work is being done to develop standardized pipe and fittings, such as joints and valves. The strength-weight ratio of such pipe is said to be superior to that of steel and aluminum, and its impact resistance is better than that of most metals. It may be used in a wide temperature range, from —60 to 275 F, and at high pressures, and has good electric and thermal insulating properties. It is also resistant to corrosion, except with some chlorinated solvents. The glass fiber reinforcing the resin may be in the form of yarn, nonwoven mats, or glass cloth or tape; the choice depends on the characteristics desired. While the initial cost is relatively high (one to two-inch pipe costs about $2 a ft), its long service life justifies use in some applications.

A Special Thermocouple for Measuring Transient Temperatures

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INTRODUCTION

THE need for an instrument to measure transient temperatures arises in numerous heat-transfer investigations. Because of their simplicity and comparatively rapid response, fine-wire thermocouples usually are employed. However, in certain applications fine-wire thermocouples are unsatisfactory because of their lack of strength and difficulties in positioning the junction at the point of interest. Furthermore, the minimum size of the junction, which affects the rate of response, usually is limited to the wire diameter.

The purpose of this paper is to describe a special thermocouple having a junction thickness of only 1 micron, which is of such rugged construction that it may be employed to measure extremely rapid temperature changes in regions of high stress. The development of this thermocouple was undertaken, under the sponsorship of the Office, Chief of Ordnance (ORDTS), to provide a means for measuring gun-bore surface temperatures.

The basic principles utilized in this thermocouple were taken from a report[1] by P. Hackemann which describes a special thermocouple developed in Germany during the last war.

DESCRIPTION

In the course of the development, several thermocouple designs were fabricated and tested. The one which has proved most successful to date is shown in Fig. 1, and in cross section in Fig. 2. The major parts are the probe, body, terminal posts, and insulator. The most important of these is the probe which contains the junction. The probe consists of a thick-walled steel tube plated on one end with a thin layer (1 micron, i.e., 0.000039 in. thick) of nickel. The interface between the nickel plating and the underlying end of the steel tubing is the plane at which the thermal emf is generated. The lead wire to the plating is mounted in the center of the tubing. This wire also is made of nickel, and is coated with an oxide of nickel which serves as electrical insulation between the nickel wire and the steel tubing. The diameter of the probe is 0.090 in. and its length has been varied from $^5/_{16}$ to $^1/_2$ in.

The probe is held in a steel body. The body is equipped with external threads which are used to mount the unit, and also contains the binding post for attaching the external steel lead wire. Since the only electrical contact desired between the nickel and the steel is that existing at the hot junction, a lucite insulator is employed between the steel body and the nickel terminal post. The internal nickel lead wire from the probe is insulated throughout its length from the steel parts of the thermocouple, and is clamped firmly to the nickel terminal post. The over-all length of this thermocouple is approximately 3 in.

The first design which was fabricated successfully is shown in Fig. 3. It will be noted that the probe was the same as the one used in the design previously described. The small lucite insulator and the method of joining the internal lead wire to the nickel terminal post, however, proved to be undependable under test, although a number of very satisfactory records were obtained with this thermocouple.

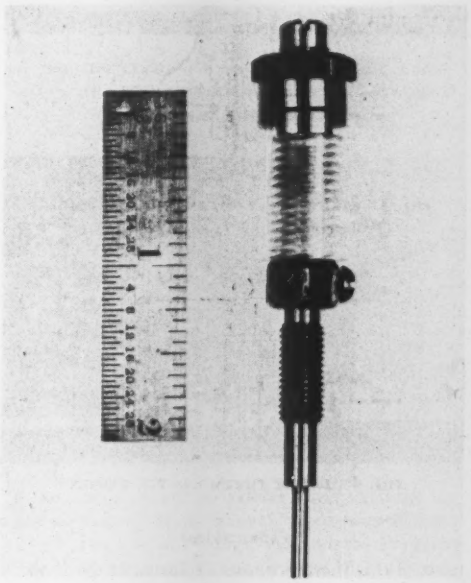

FIG. 1 COMPLETE THERMOCOUPLE
(Sensitive surface at extreme lower end.)

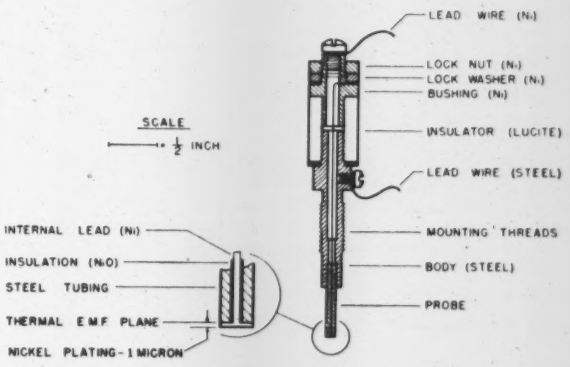

FIG. 2 CROSS SECTION OF THERMOCOUPLE SHOWN IN FIG. 1
(Hot junction or thermal emf plane is at interface between nickel plating and steel tubing.)

[1] "A Method for Measuring Rapidly Changing Surface Temperatures and Its Application to Gun Barrels," by P. Hackemann, Theoretical Research Translation, 1/46 Armament Research Department.

Contributed by the Heat Transfer and Industrial Instruments and Regulators Divisions and presented at the Annual Meeting, New York, N. Y., November 30–December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

The latest design, shown in Fig. 4, now under development, reduces the unit to its bare essentials. The probe itself is threaded for mounting purposes so that no separate body is required, and the internal nickel wire is connected directly to the external lead so that no separate terminal post or insulator is required.

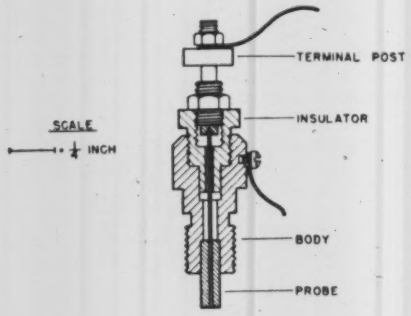

FIG. 3 PRELIMINARY THERMOCOUPLE DESIGN
(Probe construction same as in Fig. 2.)

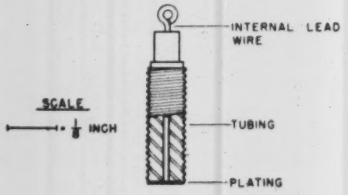

FIG. 4 LATEST THERMOCOUPLE DESIGN

FABRICATION

All parts of this thermocouple, exclusive of the probe, can be fabricated with conventional machine-shop tools and present no difficulty. The development of procedures to fabricate the probe was the main problem. The basic steps in the fabrication of the probe are as follows:

1 Preparation of the tubing.
2 Preparation of the internal lead wire.
3 Mounting the lead wire in the tubing.
4 Preparation of the end of the wire-tubing assembly.
5 Deposition of the plating.

Preparation of Tubing. The tubing is made from SAE 4130 steel, furnished by the tubing manufacturer in an annealed state in 6-ft lengths. The outside diameter is 0.10 in. and the inside diameter 0.010 in. It is cut into approximately $2^1/_2$-in. lengths which are then tapered on one end and chamfered on the other end. Starting at the chamfered end, the tubing ID is enlarged to 0.0135 in. with a No. 80 twist drill for a depth of approximately $^3/_4$ in. To avoid excessive drill breakage, the tubing is turned in a lathe and the drill is applied by hand, being removed and oiled periodically. The hole is then lapped, using a revolving music wire coated with a mixture of levigated alumina and oil. The finished hole is cleaned by flushing with carbon tetrachloride. A sectional view of a prepared tubing is shown in Fig. 5.

Preparation of Internal Lead Wire. The wire is 0.012 in. diam. "A" nickel. It is cut into approximately $4^1/_2$-in. lengths, cleaned with carbon tetrachloride, and electrically heated for 1 hr to approximately 2000 F in a circulating atmosphere of CO_2 at ambient temperature. This forms on the wire a thin but durable layer of nickel oxide, which has good electrical insulating properties. The first oxides tested were formed by heating the wire in air. It was found that these are more adversely affected by subsequent heating than those formed in CO_2.

Mounting Lead Wire in Tubing. One end of the oxidized nickel wire is inserted into the lapped hole in the tubing until it bottoms. Care must be taken in this step to avoid scraping the oxide. A small amount of Duco cement is applied at the end of the tubing to hold the wire in place temporarily. The tapered end of the tubing is threaded through a wire-drawing die, 0.090 in. diam., and the entire length of tubing is drawn through the die. This operation compresses the tubing around the insulated wire. In order to avoid damage to the thin oxide layer during this operation, care must be taken in the preparations of the tubing-holes (step 1) to insure that it is round and smooth.

Preparation of End of Wire-Tubing Assembly. The wire-tubing assembly is cut approximately $^3/_4$ in. from the end in which the wire is fixed. The unit is placed in a polishing fixture and the cut end is ground and polished flat until there is no connecting metal between the nickel wire and the steel tubing. This is done with a series of abrasives starting with No. 120 sandpaper and finishing with levigated alumina. Conventional metallurgical polishing wheels are used in the final polishing operations.

To make certain there is no metal-to-metal contact between the nickel wire and the steel tubing, electrical resistance between the two is measured. For this purpose a special ohmmeter was constructed which does not induce more than 50 millivolts. It was found that the 3 or 4 volts induced by conventional ohmmeters damage the thin oxide.

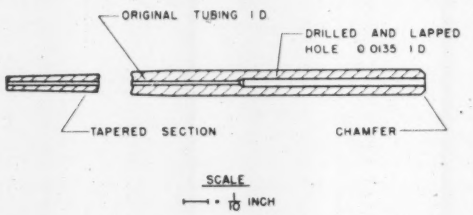

FIG. 5 SECTIONAL VIEW OF PREPARED STEEL TUBING USED IN FABRICATION OF THERMOCOUPLE PROBE
(Over-all length is approximately $2^1/_2$ in.)

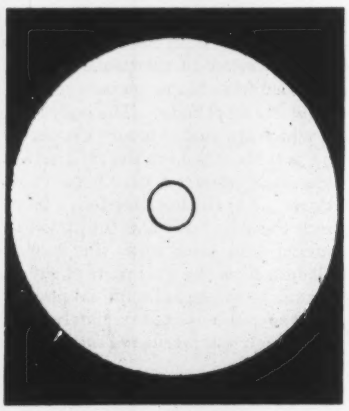

FIG. 6 PHOTOMICROGRAPH OF POLISHED END OF THERMOCOUPLE PROBE READY FOR PLATING
(Note nickel-oxide insulation—dark ring—between internal nickel wire and steel tubing.)

Fig. 6 is a photomicrograph of the polished end of a wire-tubing assembly showing the nickel wire, the thin oxide insulator, and the surrounding steel tubing. Notice the absence of any metal contact between the wire and the tubing.

Where a separate body is used, the next step in the procedure is to press-fit the probe into the body, using a small hydraulic press. The main precautions in this step are to avoid injury to the polished edge of the probe, and excessive pressure which may cause the tubing to bulge. If the polished end is protected by a soft plate, such as brass, and the press force is kept below 550 lb, usually no injury results.

Deposition of Plating. The polished end of the wire-tubing assembly is plated with a thin layer (1 micron) of "A" nickel utilizing the evaporation-under-vacuum process. This process was selected because of its ability to deposit the nickel on the nonconductive oxide surface. Both electrodeposition and chemical[2] plating procedures were tried with limited success. In the evaporation process, nickel deposits indiscriminately on any exposed surface so that a continuous plating over the entire polished end of the wire-tubing assembly is therefore obtainable.

The filament from which the nickel charge is evaporated is made from 0.025-in-diam tungsten wire formed into a helical coil of 20 turns spaced 1/4 in. apart. The nickel charge consists of 5 turns of 0.010-in-diam nickel wire wrapped tightly around each loop of the filament.

The plating thickness is controlled by the distance of the filament from the surface to be plated, which is the polished end of the wire-tubing assembly. To determine the proper distance in order to obtain 1 micron of plating, specimens were plated at various distances from the filament. These specimens were

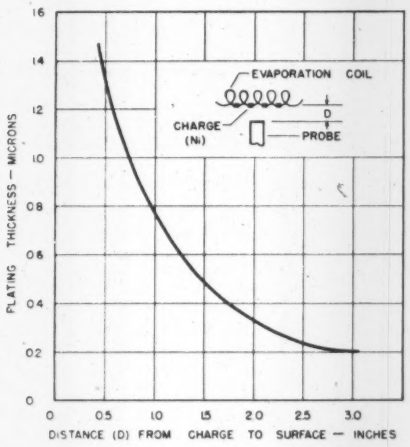

FIG. 7 PLATING-THICKNESS VARIATION WITH DISTANCE FROM CHARGE TO PROBE SURFACE, OBTAINED IN EVAPORATION-PLATING PROCESS

sectioned, magnified, and the plating thickness measured. The results are shown in Fig. 7, which indicated that a plating thickness of 1 micron is deposited when the filament is positioned 0.75 in. from the end of the wire-tubing assembly.

A photomicrograph of a 45-deg section through the plated end of the thermocouple is shown in Fig. 8. Fig. 9 is an enlargement of Fig. 8 clearly showing the nickel plating bridging the nickel-oxide layer and making contact with

[2] "Nickel Plating on Steel by Chemical Reduction," A. Breernn and G. E. Riddell, National Burea uof Standards, *Journal of Research*, vol. 37, 1946.

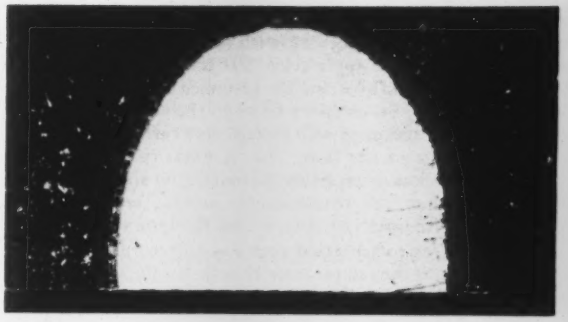

FIG. 8 PHOTOMICROGRAPH SHOWING 45-DEG CROSS SECTION THROUGH SENSITIVE END OF THERMOCOUPLE
(Streaks caused by polishing process.)

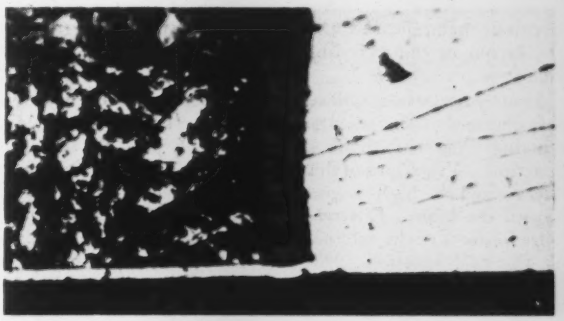

FIG. 9 ENLARGED VIEW OF LOWER LEFT CORNER OF FIG. 8, SHOWING NICKEL PLATING—BRIGHT BAND—DEPOSITED ON STEEL TUBING AT LEFT, NICKEL OXIDE INSULATION AT CENTER, AND INTERNAL NICKEL LEAD WIRE AT RIGHT

the steel tubing and the inner nickel wire. The plating thickness on this particular specimen is approximately 1.5 microns.

One of the problems in this plating process was to obtain a reasonable amount of adhesion of the plating to the steel tubing. Various cleaning procedures were tried without success. Finally, heat was applied to the wire-tubing assembly just prior to evaporation of the nickel charge. This produced a bond between the plating and the assembly end such that the plating could not be removed with Scotch tape. Further experiments indicated that the wire-tubing assembly must be at a minimum of 750 F at the time the nickel is deposited in order to obtain this adhesion.

INSTALLATION AND RECORDING EQUIPMENT

To a certain extent the method for installing the thermocouple and recording its emf output depends on the particular application. In general, the thermocouple should be installed so that the heat is applied to the exposed surface of the plating, and the recording equipment should be capable of faithfully reproducing the emf generated by the thermocouple circuit.

The thermocouple is mounted in an appropriate hole in the wall at the station of interest. If the wall is sufficiently thick or the latest thermocouple design is employed, the unit is threaded directly into the specimen wall; otherwise it is necessary to provide a mounting bracket attached to the specimen wall. In any event the plated end of the thermocouple is positioned so that it is flush with the wall surface of interest

as shown in Fig. 10. The accuracy with which the end of the thermocouple must be lined up with the specimen wall surface again depends on the application. If the flow of the heating (or cooling) medium affecting the specimen surface temperature is laminar, it may be necessary to align the end of the thermocouple with the specimen wall surface very carefully in order to avoid disruption of the flow. In recoilless-rifle experiments, where the gas flow is probably turbulent, no significant effect was noted when the thermocouple surface was positioned purposely approximately $^1/_{16}$ in. below the bore surface.

As for the instrumentation required to record the thermocouple output, if the temperature change is sufficiently slow, a hand-balanced potentiometer may be satisfactory. For rapid transients it is necessary to employ a cathode-ray oscilloscope with associated amplifiers. In certain recoilless-rifle experiments a Tektronix Type 512 cathode-ray oscilloscope is being employed in conjunction with a Tektronix Type 122 preamplifier. The oscilloscope trace is photographed with a 35-mm camera. The reference junction of the thermocouple circuit is maintained at 32 F in an ice bath. Fig. 11 shows the layout of the recording system being employed in these rifle tests.

In early records a considerable amount of high-frequency hash was obtained. This was traced to the external nickel lead wire running from the thermocouple binding post to the cold junction. Vibrations of the rifle during firing cause this wire to vibrate and the high magnetostriction characteristics of nickel caused the hash. This was overcome by substituting copper wire for most of the external lead, with nickel maintained only at the cold junction. No error is introduced by this substitution, since the two copper-nickel junctions thus formed are both at ambient temperature.

CHARACTERISTICS

A thermocouple which is to be used to measure rapid temperature transients of course must have an appropriately short response delay. One of the principal factors which controls the speed of response of thermocouples is the time required to heat the junction between the two metals.

In the thermocouple herein described, the junction between the two metals (steel and nickel) is at the interface between the nickel plating and the underlying steel tubing. Therefore, heat applied to the exposed surface of this thermocouple is required to penetrate only 1 micron of nickel (the plating thickness) in order to heat the junction. Consequently, very little time is required for this thermocouple to respond to temperature changes at the exposed surface. The time constant, which is time required for the junction temperature to reach 63.2 per cent of the amplitude of a step-temperature change of the exposed plating surface, has been calculated to be in the order of $^1/_4$ microsec.

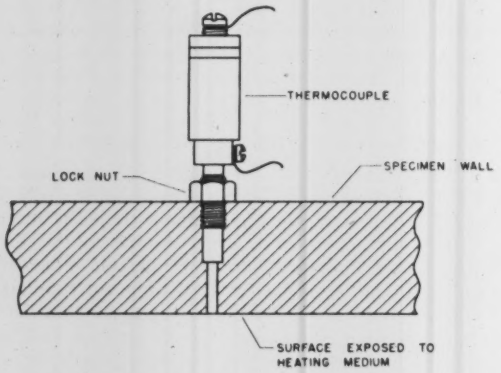

FIG. 10 TYPICAL INSTALLATION OF THERMOCOUPLE FOR MEASURING WALL-SURFACE TEMPERATURES

(Sensitive end of thermocouple aligned with exposed surface of specimen wall.)

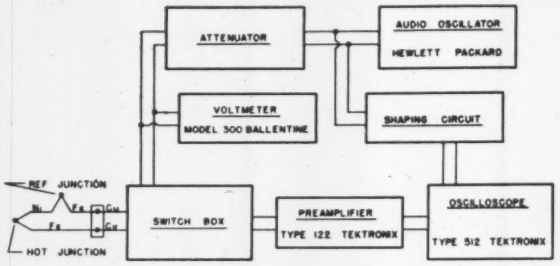

FIG. 11 LAYOUT OF EQUIPMENT FOR RECORDING RAPID TEMPERATURE CHANGES

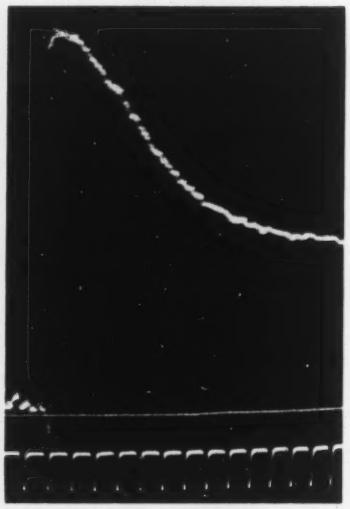

FIG. 12 TEMPERATURE-TIME OSCILLOGRAM TAKEN IN BARREL OF A RECOILLESS RIFLE

(Time intervals, below curve, represent 2 millisec; maximum temperature rise is 224 F. Notice rapid rate of initial temperature rise; namely, 800 F per millisec.)

The rapid response of this thermocouple is demonstrated in Fig. 12, which is a reproduction of a record taken in the barrel of a recoilless rifle. This shows an initial rate of rise of 800 F per millisec, the maximum temperature change (224 F) being attained in approximately 0.9 millisec.

Assuming heat is applied uniformly to the exposed flat surface of the thermocouple, the principal direction of heat flow is perpendicular to the surface. Since the junction is a plane parallel with the exposed surface, it is located in an isothermal region, at a known distance (1 micron) from the exposed surface. This feature is particularly useful, since it permits the recorded temperature variations to be extrapolated to determine the exposed surface-temperature variation. For example, the record shown in Fig. 12, which is the temperature variation at 1 micron from a gun bore, may be used to determine the temperature variation of the bore. A convenient method for ac-

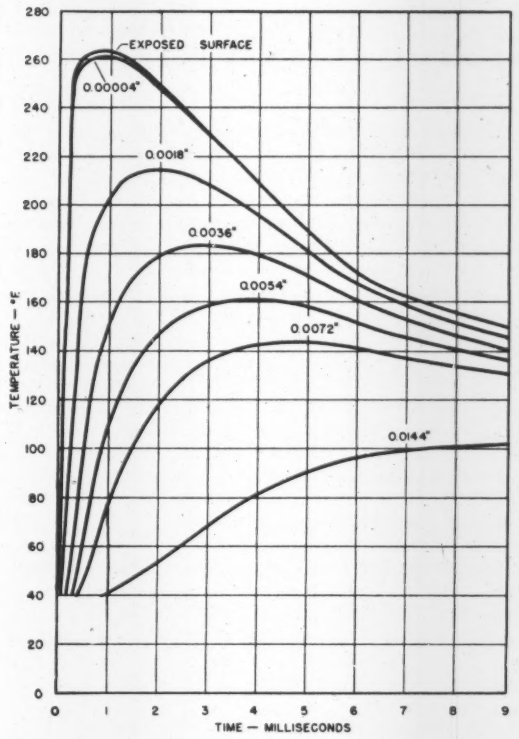

FIG. 13 TEMPERATURE HISTORIES AT VARIOUS DISTANCES FROM EXPOSED THERMOCOUPLE SURFACE

(Curve at 0.00004 in. from exposed surface obtained experimentally, Fig. 13; remaining curves derived from Schmidt procedure.)

complishing this is the Schmidt procedure[3] utilizing the recorded temperature history at 1 micron from the exposed surface as the boundary value. The result is shown in Fig. 13. This figure is interesting in that it shows how closely the recorded temperature variation represents the temperature variation at the bore surface. The maximum temperature rise at 1 micron from the bore is only about 1 deg F less than that at the bore. Also included in the same figure are the temperature variations at greater distances from the bore, which shows the rapid decrease of temperature with distance from the bore. This emphasizes the necessity for locating the thermocouple junction as close as possible to the exposed surface, if the temperature of the latter is of interest.

Obviously, it is undesirable for the installation of a thermocouple to alter the temperature of the medium to be measured. When the exposed-surface temperature of a metal wall is to be measured, it is necessary to avoid disturbance of the heating (or cooling) medium and the normal heat transfer through the wall, for both affect the temperature of the wall surface. Since the sensing surface of this thermocouple is aligned with the surrounding wall surface, there is no disturbance of the heating source. To avoid disturbing the normal flow of heat through the wall, the metals used in the thermocouple should have thermal properties as close to that of the wall material as possible. For use in gun walls, gun steel and nickel are being used.

Calibration of these steel-nickel thermocouples has been conducted under semistatic conditions. To avoid oxidation caused by heating in air, calibration has been conducted under vacuum. The calibration curve obtained is shown in Fig. 14. It is of course desirable to calibrate under transient conditions similar to those of the installation in which the units will be used. Special equipment is now being constructed for this purpose.

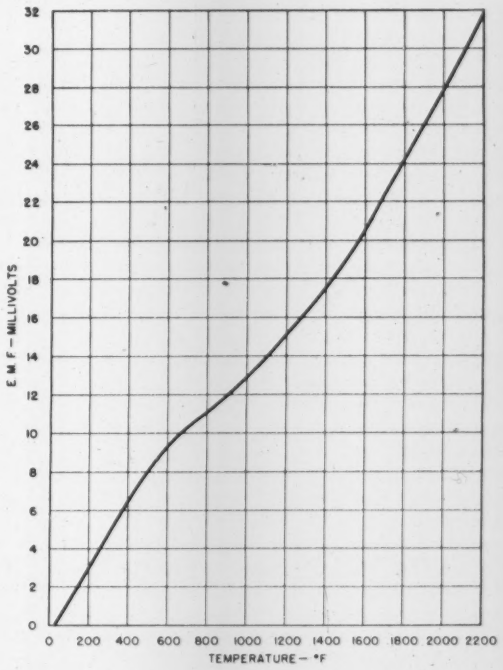

FIG. 14 CALIBRATION CURVE FOR NICKEL-STEEL THERMOCOUPLE (Reference-junction temperature maintained at 32 F.)

Experience with these thermocouples when used in recoilless rifles shows that they are able to withstand approximately 10 rounds before failure, which is usually due to wearing away of the plating by the extremely erosive powder gases. These may be reconditioned by repolishing and replating the sensing surface.

CONCLUSIONS

A rugged thermocouple with very rapid response has been developed. Although this thermocouple is particularly suited to measurement of metal-surface temperatures, its unusual features may make it worthy of consideration for other applications.

ACKNOWLEDGMENTS

The author is indebted to the various Midwest Research Institute staff members who have contributed to this development. Particular recognition is due Messrs. L. A. Platt, J. F. Puterbaugh, and C. E. Moeller. Thanks are tendered to Mr. W. J. Gorman for the preparation of the drawings used in this paper.

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[3] "Heat Transmission," W. H. McAdams. Second edition. McGraw-Hill Book Company, Inc., New York, N. Y., 1942, pp. 39–43.

Is Your New PRODUCT SAFE?

By JOHN V. GRIMALDI

DIRECTOR, INDUSTRIAL DIVISION, ASSOCIATION OF CASUALTY AND SURETY COMPANIES, NEW YORK, N. Y. MEMBER ASME

DANGEROUS PRODUCTS

ONE of the nation's largest corporations recently lost $300,000 when its new tobacco insecticide destroyed a cigarette company's stock. The insect killer was a by-product development, enthusiastically welcomed by the corporation's executives whose research department had tested and proved its lethal effect on insects. The researchers knew something of its properties, as, for example, that it had a flash point approximating that for kerosene. But they had not considered what might happen under commercial conditions outside the laboratory. The product was marketed and labeled nonflammable; then its sponsors waited for the expected profits. However, profits faded rapidly into a major loss when the new insecticide caused a financial catastrophe. It was used where a source of ignition, sufficiently hot to start its burning, was accessible, and a tobacco crop, intended for smoking pleasure, was quickly consumed and indirectly became a major irritant to all concerned.

Such occurrences are not unusual. Too often dangerous new products reach the market causing destruction to property, injuring the public, or harming its health. Just as frequently new products have damaged their manufacturing plants and surrounding buildings or have affected employees injuriously. Such unfortunate experiences cost money, and sometimes the expense is so great that the manufacturer is forced out of business. Once such misfortune occurs it is too late for anything but regrets, reparations, and reconstruction.

It is commonly accepted that there are two sound means for protecting against loss. One is the purchase of insurance which will guarantee indemnification within the limits of the policy. Another is to determine possible hazards, then control or eliminate them. These approaches, when used together, will reduce to a minimum the hazard to the reputation and bank account of any manufacturer. The mere purchase of insurance is never the solution to the loss problem. It is a mistake to believe that one can relax in security simply because an insurance policy has been issued. No policy ever prevented an accident, of course, and regardless of the possible enormity of indemnification, there are time losses and other inconveniences which cannot be absorbed by the insurance carrier. While it is a principle of engineering that the economics associated with anything new must be studied prior to submitting a recommendation for action, the record indicates frequent failure to evaluate the hazard potential, as an influence on the hoped-for dollar return.

In any undertaking it is important to know first what can and cannot be done. When the negative characteristics outweigh the positive, wisdom dictates the abandonment or revision of the idea. An analysis of a product's inherent hazardousness to the public, to industrial users, and to property is entirely necessary in order to reduce the possibility of the product's being saddled eventually with conditions that will raise production costs as the result of litigation based on alleged liability following injury to the public or to property through exposure to the manufacturer's product.

Contributed by the Safety Division and presented at the Annual Meeting, New York, N. Y., November 30-December 5, 1952, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

J. M. Crawford, president of the Indemnity Insurance Company of North America, recently pointed out that in a short space of time the policy of *caveat emptor* (buyer, beware!) has changed to one of *caveat venditor* (seller, beware!). Mr. Crawford says: "Every manufacturer and vendor, regardless of what he makes or sells, is constantly exposed to claims for injuries from those who consume, use, or handle his products, or happen to be in the vicinity of them when something goes wrong. In this situation, the job of product liability insurance is to assume the loss resulting from these claims, and to provide a service to the insured manufacturer or vendor through expert investigation and defense."

The question is not whether the manufacturer is right or wrong concerning the hazards of his product. He must know and be able to prove that his product is free from hidden hazards when any liability claims are made against him. Although a manufacturer is not yet required to produce an "accident-proof" product free of both latent and recognizable hazards, he is often called upon to defend such suits. In New York a man injured his hands when they became caught in the spinning steel rollers of an onion-topping machine. He alleged negligence, stating the machine should have been equipped with a guard or stopping device. It was not alleged that the machine possessed any hazard not recognizable to the complainant. This manufacturer suffered only the cost of the court action, for the complaint was dismissed with the opinion, "In point of fact . . . a duty is owed, a liability imposed, only if the defect or danger be not 'known' or 'patent' or 'discoverable' by a reasonable inspection." However, the problem is not always solved so readily. It is not simple to settle whether a product is inherently dangerous or negligently made and marked. The facts in each case direct the conclusion. A $65,000 judgment was awarded in Illinois when an electric vaporizer not equipped with a thermostat to interrupt the current upon overheating, set fire to a baby's room, burning the child.

FALSE SENSE OF SECURITY

Many manufacturers believe that as long as they have insurance coverage they no longer have responsibility. It is their belief that the insurance company is responsible for all liability claims that may be placed, falsely or truly, against hazards found in their products and thereby has assumed a responsibility for safety. This is obtuse thinking, or it is not realized that insurance premiums are based upon rates established by the loss experience. When experience is poor over a period of time, the rates necessarily have to go higher. Conversely, when the experience is good the rates are reduced. Furthermore, insurance coverages do not always provide for dollar payment equivalent to the total amount of claims or settlement. Insurance protection extends only to the limits of the policy. Any difference is paid by the manufacturer.

In general, products liability contracts cover accidents that occur off the premises of the insured, and after the insured has relinquished possession of the product. Thus it can be seen that the manufacturer can be sued for deficiencies in his product which result in injury to the public or damage to property and which are not included in the scope of products liability coverage. In addition, he may be sued for an amount that is outside the limits of the products liability coverage he has

bought. These claims, obviously, can be extremely costly. In addition, if his product is an extreme hazard to the public or its property it may mean that he has to withdraw it from the market, thereby compelling him to lose all the money and time he spent in research and in setting up the production process.

Decisions of the court have established that from the legal point of view, "products can be used safely by almost everyone." Materials, like cosmetics, cannot be defended from claims by those who are affected by them on the grounds that "most people can use them safely." It has been pointed out that "recent decisions are eroding the security of the once useful defense that the plaintiff's injury was due to a peculiar susceptibility to things which do not generally result in harmful conditions." A recent court case has established: "The mere fact that only a small proportion of those who use a certain article would suffer injuries by reason of such use does not absolve the vendor from liability under the implied warranty created by the statute; otherwise, in every action to recover damage. . . it would be necessary to show that the article sold . . . would injure every user."

Experience can develop almost a limitless number of cases demonstrating the high cost to manufacturers for not predetermining hazards inherent in the new products they are producing. In some cases, the hazards have resulted in the necessity of withdrawing the product from the market completely. Total cost in most of these cases is almost impossible to determine. However, the extremeness of the cost is apparent in almost every instance

HAZARDOUS PRODUCTS AN OLD STORY

The failure to determine the harmful effects on the public of new products and thereby to create a hazardous condition that has seriously affected the welfare of the public is not a new problem. In the 1800's our ancestral budding scientists found that when they mixed benzene and nitric acid they obtained a compound which resembled oil of bitter almonds so closely that they immediately marketed its combined form as a flavoring material. This product, mononitro benzene, resulted in the death of several hundred people before it was withdrawn from the market. It is inconceivable that anyone would wish to sell a product which would be harmful to other people, yet this one and many others were marketed without any apparent consideration to possible hazards.

A manufacturer in Chicago marketed a cold degreasant, tetrachlorethane, to be used by the dipping method. The directions for its use called for approximately 500 gal to be placed in a tank about 12 ft × 4 ft × 5 ft in size. The solvent was to be covered with a layer of water approximately 3 in. in depth. The only reason for this, according to the manufacturer, was an economical one to prevent undue loss of the compound due to evaporation. (In some cases it is recommended that water be placed over a highly volatile toxic substance of this type to reduce the health hazard caused when the material evaporates). There were no other warnings or instructions regarding possible hazards to materials immersed in the degreasant or to employees working with it. One user followed all instructions. He was degreasing 8 to 10-ft lengths of fluorescent light fixtures and soon discovered that the degreased metal rusted in an increasing degree after the compound had been used for a week. The rusting progressed to such a point that in the space of a few hours the entire surface of the metal was coated with an unwanted film. Obviously the tetrachlorethane was hydrolyzing to form hydrochloric acid.

The manufacturer of the solvent, when questioned about this condition, stated that it would be well to use a fresh supply of the solvent without any further use of the protective layer of water. This was done and the rusting stopped. It was then noted that the solvent vapors were noticeably disseminated throughout the workroom atmosphere. In fact, the odor of the solvent could be noted in the office when stepping into the plant. (The office was some 60 ft distant from the solvent tank and separated by two partition walls.) An analysis of the air showed that it contained tetrachlorethane in an average of 30 to 60 ppm. (The safe concentration of tetrachlorethane is not to exceed 10 ppm.)

The producer of this solvent was placed in the middle of two extremes. In the first instance, his product, when used as recommended, was severely damaging the material being processed. In the second instance, when the recommended safeguarding water layer was removed, the product created a toxic contamination of the air which severely influenced the health of the workers. This is a clear-cut case of incomplete knowledge on the part of the manufacturer as to the properties and toxicity of his material. From the standpoint of present knowledge, he could not have picked a more hazardous solvent than tetrachlorethane. The manufacturer suffered a high financial loss due to liability claims and the necessity of recalling his product from the market.

A products property-damage policy with a $25,000 limit was written on a new calcium-chloride antifreeze solution. The antifreeze was claimed to be noncorrosive because of the absence of any sodium chloride. A cursory laboratory test was made purporting to prove noncorrosiveness to motor blocks and radiators. Samples of each of several metals had been suspended separately in the solution, in such a manner that there was no contact of the dissimilar metals. Therefore the test was not analogous to the conditions in an automotive power system. When the solution was used commercially, the contacting dissimilar metals set up an electrolytic cell, breaking down the solution to form a corrosive by-product. Hundreds of claims resulted at an average cost of $100 each. Within 3 months after the product was marketed, the losses exceeded the policy limit. After 9 months the claim total had reached $100,000 and the company was bankrupt.

PUBLIC MUST BE NOTIFIED OF PRODUCT HAZARDS

Not only must the manufacturer of a new product determine its hazards, but he must also notify the public of the inherent hazards and instruct them as to how his product can be used with safety. Therefore proper labeling of a product to indicate its hazards is of great importance, and the manufacturer should include as complete instructions as possible concerning the use of products when they are dangerous. For example, a flame thrower was produced for the purpose of burning weeds, disinfecting poultry yards, and melting ice and snow. It was designed to be fueled with kerosene or stove oil, but the label did not so state. No warning, implied or specific, was given concerning the hazardousness of using other fuels, such as gasoline. One user operated it with gasoline and the rubber hose on the unit split. When it failed, all fuel in the tank and the entire apparatus burned, causing the operator to be badly burned. An investigation of the accident showed that it would have been avoided if the user had not used gasoline. The claim amounted to many thousands of dollars.

The importance of proper labeling cannot be overemphasized. A dry-cleaning liquid called "Safety-Kleen" had on its label the words, 'Caution: Use in a Well-Ventilated Place. Do Not Inhale Fumes." A housewife cleaned rugs with it indoors—and died. The husband sued and won $10,000. The court stated: "that the fluid the defendant sold for general use in cleaning fabrics is highly dangerous as proved by the tragic result in this case. That the fluid would be used in places 'where it was not 'well ventilated'. . . . might reasonably have been foreseen by the defendant. That the word 'Safety' was

so conspicuously displayed on all four sides of the can of this dangerous fluid as to make the word 'Caution' and the admonition against inhaling fumes and to use only in a well-ventilated place seem of comparatively minor import." This is an example of failing to label properly. It can be just as costly to the manufacturer as neglecting to determine the hazardousness of his product prior to marketing.

Fluoroscopic shoe-fitting machines are common. They were on the market for some time before their potential hazardousness resulted in serious injury to members of the public and consequent substantial financial loss. Recently, a case occurred in New York, where a young girl model suffered a leg amputation following an excessive exposure to one of these shoe-fitting machines. Following the accident, studies were made of the radiation hazard. It was found that many of the machines were hazardous not only to the people using them, but also to the operators and other clerks in the shoe stores. It has since been shown that through the frequent use of these machines there is a possibility of damaging the bones of the feet of growing children. The manufacturer was required to redesign the equipment and redraft the operating instructions, so that the maximum exposure to the public would be one roentgen per viewing, with a maximum of three viewings per day and twelve viewings per year. It has been found that in some cases there was an exposure to 140–150 roentgens per viewing. By operating the machines at a current of 3 milliamp or less and restricting the viewing time, along with lead shielding, $^1/_8$ in. thick, around the machine, a good deal of the hazard was eliminated. The exact cost for the design changes and liability claim settlements is not available, but it obviously was not a negligible amount.

Some years ago a manufacturer marketed a resin-ester textile finish which was supposed to strengthen the textile fibers. The material performed its task very satisfactorily, but unfortunately it was very irritating to the skin of about 5 per cent of the users. The compound was used frequently on various articles of clothing. It was first used on women's underwear in Canada where it was found to be irritating and its use was discarded. Following this, the finish was then used on women's stockings and on men's shorts, in both cases producing irritation of the skin. In fact, in some cases the irritation was so severe that the wearers were made ill. The total losses of this ill-fated product are unobtainable, but the enormity of the figure is indicated by the $68,000 in damages claimed by users of the treated stockings alone.

STUDY THE REGULATIONS

Every manufacturer of a new product should first determine what laws or regulations, if any, govern the product that he is manufacturing. Many states have laws pertaining to pure foods, drugs, and cosmetics. Laws vary in each state and great importance is placed on labeling, ingredients, and particularly, instructions for use, guarantees, and so on. The manufacturer also should have a laboratory check the following:

1 The inherent hazards of the product that may affect the plant structure or equipment. These would include fire hazards which result from spontaneous ignition, and the possible augmenting by the product of any fire hazards that may otherwise be present in the plant. For example, carbon tetrachloride is often mixed with other solvents to produce less flammable mixtures or to increase their solvent power. If the other solvent is less volatile than carbon tetrachloride, the carbon tetrachloride will evaporate, changing the composition of the mixture; if the second solvent is flammable, the evaporation of the carbon tetrachloride will result in an increasingly flammable mixture. On the other hand, if a flammable solvent is more volatile than carbon tetrachloride, the vapors may be highly flammable even if the liquid mixture itself is not.

The effect of the product upon the structure of the plant should be investigated as well. One manufacturer of a halogen salt carried out his process under such poor conditions that the salt was permitted to remain in contact, when wet, with the concrete floor of the plant. It severely deteriorated the concrete to the point where the entire floor structure was weakened. In general, to protect his plant, the manufacturer should have accurate knowledge of the flash points, ignition temperatures, corrosiveness, vapor pressures, and other physical properties of his product and the materials that enter into its manufacture. He should know and apply the safe methods for handling and storing hazardous materials.

2 Health hazards to production personnel should be considered as well. These may be more pronounced than the hazards to the public and may create a condition so dangerous that it would be impractical or impossible to produce the product economically. An example of this is the former use of beryllium-silicate phosphors for coating fluorescent and cathode tubes. The beryllium in these phosphors caused an acute and chronic lung condition in production workers, resulting in the death of many and finally requiring the discontinuance of the use of this material after many claims and much expense had been recorded.

New products should be examined to determine the toxicity of the product and the material used in compounding or processing it. Toxicity should be investigated with respect to the possibility of systemic poisoning occurring either through skin absorption, inhalation, or ingestion. They also should be investigated with respect to their corrosiveness to tissue by either the product or the material used in the production process.

3 The production process itself should be examined with respect to the possibility of its causing traumatic injury to personnel during its operation.

4 The possibility of injuring the public through use of or exposure to the product should be determined. The following points should be checked and found to be satisfactory before marketing the product:

(*a*) Corrosiveness of the product to tissue.

(*b*) The toxicity of the product either through skin absorption, inhalation, or ingestion.

(*c*) The possibility of traumatic injury by the product.

5 Hazards to property should be given serious consideration. A product should be examined with respect to its corrosiveness to material, its solvent action on substances that accidentally might come in contact with it, its discoloration qualities, and its fire and explosion hazards. Some painstaking investigating first may save some painful expenses later.

EVALUATING THE COST STRUCTURE

When the potential hazards are identified, it is possible to evaluate the cost, if any, for their elimination by reprocessing or remaking the product. Such analysis always should be a part of the preliminary critical determination of the potential profits or losses to be derived from making a new product. It may be that a manufacturer believes that his product does not need such investigation because of its harmless appearance and because of the type of market he intends to sell. However, it is always better to check first with the appropriate technical specialist. The manufacturer of boys' cowboy suits, for example, probably thought his product would cause no harm. He made cowboy "chaps" of brushed rayon which looked very much like the real chaps used by the wildest of the wild-west heroes. He did not realize, and conducted no

(*Continued on page 148*)

HANDLING COAL *and* ASHES
Economically in Smaller Plants

By D. M. GIVEN[1] and C. A. MARSHALL[2]

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THERE are any number of coal and ash-handling systems that can be used in the smaller boiler plants to provide the laborsavings and convenience required for management's acceptance of coal as a fuel. However, the engineer co-ordinating the project must be careful to select a system which is economical of fixed charges as well as operating costs. The following discussion relates to this problem and illustrates some of the methods by which it may be resolved for plants burning less than 30,000 tons of coal annually.

CAPITAL INVESTMENT

In balancing fixed charges against operating costs to evaluate different handling systems, it is desirable to consider all handling charges on a common basis of cost per ton of coal consumption. Both coal and ash handling can be related to this same common denominator by simply dividing annual costs by the annual rate of coal consumption.

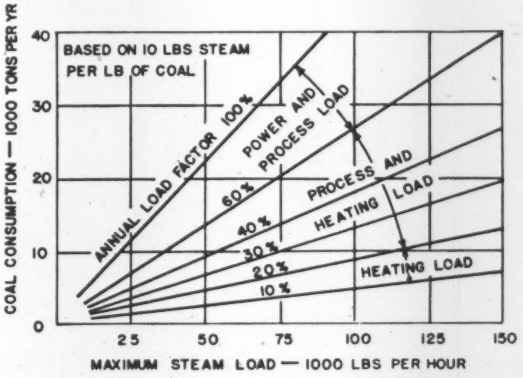

FIG. 1 ESTIMATING ANNUAL COAL CONSUMPTION

In the case of a new plant, the annual rate of coal consumption may be estimated from Fig. 1, using the appropriate annual load factors as indicated. The load factor is a percentage of the maximum steam load (not of boiler capacity) representing the average steaming rate for the full 8760 hr in a year.

Fig. 2 gives typical installed costs of handling systems that are considered adequate for different sizes of plants. It also indicates that fixed charges can be controlled to about 45 or 50 cents per ton of coal consumption, using a conservative fixed-charge rate of 15 per cent per year. The slope of the cost curves changes abruptly at several points where, because of a reduction in handling requirements, it is possible to simplify the equipment selection. If the designer attempts to scale down large-

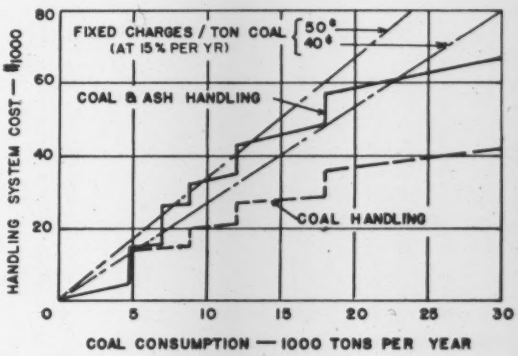

FIG. 2 TYPICAL INSTALLED COSTS OF WELL-DESIGNED HANDLING SYSTEMS

plant systems and ignores the indicated breaks in the cost curves, higher fixed charges will result.

Later in the paper, the handling systems considered in Fig. 2 will be described. For the moment, however, it should be noted that these systems include all of the basic essentials for controlling operating costs to less than 50 cents per ton for an over-all handling cost not to exceed $1 per ton of coal consumption. The operating costs are limited to 25 cents for labor, 2 cents for power, and 23 cents for maintenance.

LABOR REQUIREMENTS

Table 1 shows the labor charges per ton for full-time coal and ash men in various sizes of plants, based on an annual wage of $3600. It also shows that the limit of 25 cents per ton will not support any full-time handling labor in plants burning less than about 15,000 tons of coal per year. For these plant sizes, it is therefore required to avoid any job classifications that cannot be assigned either to the boiler operator or to part-time labor. Yard work such as unloading coal cars and moving coal to and from an emergency storage pile properly can be considered part-time work. All other handling operations should be mechanized to the extent that they can be performed by the boiler operator without neglect of his other duties.

If the storage bin is adequate for a one-week supply of coal, there will be no necessity to disturb the ground storage except in emergencies when the mines or railroads are prevented from

TABLE 1 LABOR COST PER TON OF COAL AT $3600 ANNUAL WAGE RATE

Coal used, tons/year	Labor cost, dollars/ton		
	1 man	2 men	3 men
1500	2.40	4.80	7.20
6000	0.60	1.20	1.80
10000	0.36	0.72	1.08
15000	0.24	0.48	0.72
20000	0.18	0.36	0.54
30000	0.12	0.24	0.36

[1] Fuel Engineer. Junior, ASME.
[2] Managing Director. Mem. ASME.

Contributed by the Fuels Division and presented at the 15th Annual ASME-AIME Fuels Conference, Philadelphia, Pa., October 30–31, 1952, of The American Society of Mechanical Engineers.

FIG. 3 INEXPENSIVE CAR SHAKER
(Courtesy National Conveyor & Supply Company.)

making deliveries. Thus, the yard work can be limited normally to unloading coal from railroad cars or trucks directly to the storage bin.

In plants of a size where railroad cars are unloaded with part-time labor, consumption will average not more than one car per day. Also, with a one-week storage bin the cars will not have to be unloaded the day they arrive in the event a yardman is not available that day. They should be unloaded by the second day, however, to avoid demurrage. It is also important to provide conveyer capacity of at least 25 tons per hr from track to storage bin so that a 50-ton car may be unloaded in 2 hr or less. One part-time man working 2 hr would cost 8 cents per ton based on a wage rate of $2 per hr.

Larger plants, using a full-time yardman, would require higher conveyer capacities to limit unloading operations to one shift. Allowance also should be made for the "bunching" of car deliveries, so that conveyer capacity should permit one-shift unloading of 3 to 4 days' coal requirements. A 26,000-ton per year plant should have 50-ton per hr unloading facilities.

The next problem is to provide for emptying the cars as fast as the conveyers can move away the coal. For this reason, it is often desirable to use double-screened sizes of coal in plants which cannot justify a car shaker and car-thawing equipment.

Fig. 3 illustrates a light-duty car shaker which can be installed for approximately $1700 including the jib crane and hoist for moving it into position. Plants burning as little as 8000 tons of coal annually can easily justify this nominal investment to eliminate drudgery and extra labor requirements in unloading slack sizes of coal. Heavier models cost from $12,000 to $18,000 installed, but are primarily intended for plants burning more than about 60,000 tons of coal annually. None of the car shakers will eliminate the need for first thawing the hoppers of a car in which the coal has become frozen, but all of them will empty a car faster than a 50-ton per hr conveyer can move away the coal.

Where there is a possibility of receiving coal in a frozen condition, it is important to provide car-thawing equipment. Fig. 4 illustrates a portable unit priced at $262. It normally burns kerosene or light oil and will thaw the hoppers of a car in less than an hour without manual attention. In larger plants, thawing pits are installed under the tracks at a cost of $1500 per unit. Three pits will thaw a three-hopper car in 20 min without necessity for moving the car.

MAINTENANCE REQUIREMENTS

In the interest of controlling investment costs, it is not always possible to select the types of handling equipment which offer the lowest maintenance costs. Thus, maintenance of handling equipment may be expected to average as much as 15 to 25 cents per ton of coal consumption in the sizes of plants being considered. Even higher costs might be encountered with systems that are not designed properly.

TYPICAL INSTALLATIONS UNDER $5000

Fig. 2 indicates an investment limit of from $500 to $5000 for plants burning less than 5000 tons of coal annually. Off-track plants receiving coal by truck directly to the storage bin need mechanization only from storage bin to stoker. Rail deliveries necessitate additional equipment for unloading to the storage bin except where the siding is located directly over the storage area.

A portable belt conveyer inserted into a shallow pit below the tracks will move the coal to the storage bin. These usually cost between $300 and $1500, depending on the length and model selected. In certain cases it may be desirable to spend

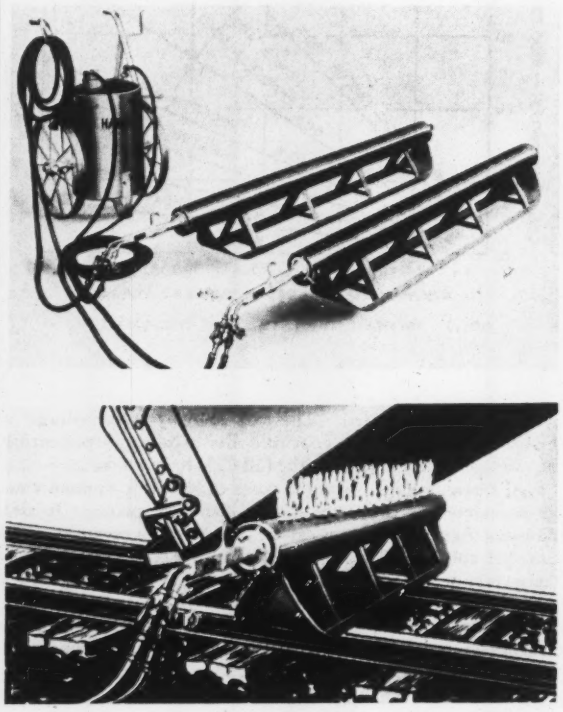

FIG. 4 PORTABLE CAR-THAWING EQUIPMENT
(Courtesy Hauck Manufacturing Company.)

another $1000 for a portable car unloader to eliminate the need for pitting below the tracks. This unit rests on top of the tracks and moves the coal out from under the car to the portable conveyer.

The following discussion suggests several methods for handling coal from the storage bin to the stoker hoppers and for handling ashes.

Monorail Hoist. Fig. 5 shows a simple monorail-hoist system for handling both coal and ashes. Installed cost runs from $500 to $1000. The boiler operator fills the wheel-mounted bucket with coal and pushes it to the stoker hoppers. It is then hoisted and pushed along a monorail track for dumping directly to the stoker hoppers. Extending the track only over the stoker hoppers eliminates the need for elaborate track layouts and electrification systems. Bucket capacities to 700 lb are practical, the stoker hoppers being modified as necessary to accommodate the size of bucket selected.

Lift Truck. Fig. 6 shows an industrial lift truck with scoop attachment for handling both coal and ashes. Prices range from $2800 to $4500, depending on capacity and type of tires selected. Bucket capacities from 750 to 2000 lb are practical. Pneumatic-tired models (not shown) are preferred for outside work. Plants with an elevated siding next to the boilerhouse may store the coal directly below the tracks, in which case the boiler operator can ride the truck to the storage area and immediately return with a load of coal for the stoker hoppers.

Bin-to-Stoker Feeder. Many of the smaller plants use a bin-feed stoker in which the stoker feed screw is simply extended back to the storage bin. With hopper-model stokers, a separate screw conveyer can be installed between the storage bin and the stoker hopper, as shown in Fig. 7. These conveyers can be installed for between $700 and $1500, depending on the length and diameter. Slow-speed operation and surplus capacity are recommended for screw conveyers to avoid excessive maintenance.

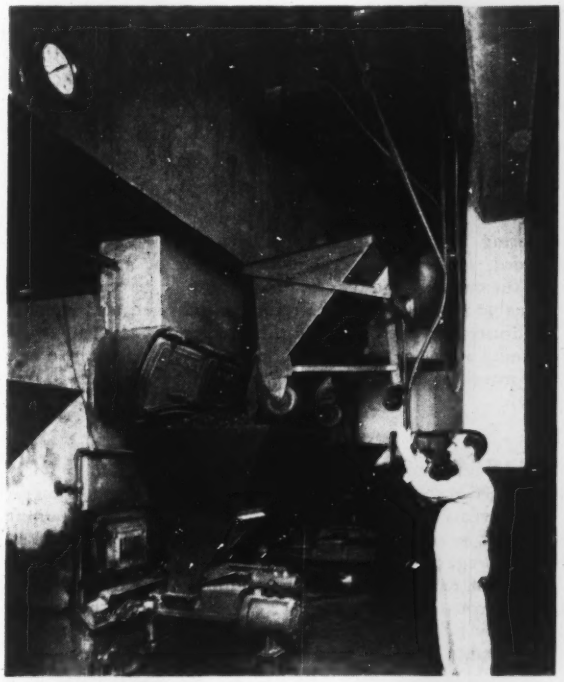

FIG. 5 MOBILE COAL AND ASH BUCKET WITH MONORAIL HOIST
(Courtesy Detroit Hoist & Machine Company.)

FIG. 6 LIFT TRUCK WITH SCOOP BUCKET
(Courtesy Clark Equipment Company.)

STATIONARY COAL-HANDLING SYSTEMS

Fig. 8 illustrates a push-button coal-handling system that with certain variations can be applied economically to most of the plants burning between 5000 and 50,000 tons of coal per year. Coal is unloaded and conveyed to the storage silo from which it is moved to the stoker hoppers as needed. The bucket elevator and feeder from the track hopper are sized according to the rate at which the railroad cars or trucks are to be unloaded. The conveyer to the stokers need only be sized according to the maximum coal-burning rates. Screw conveyers are not always practical in the unloading system but are well suited to the low-capacity operation of feeding the combustion equipment.

The silo in Fig. 8, has a live-storage shelf for feeding the screw conveyer by gravity. After the shelf is filled, the rest of the coal falls to the reserve storage space and is later reclaimed with the bucket elevator as needed. The live shelf can be eliminated, if desired, by feeding the screw conveyer directly from the bottom of the silo or from the top of the bucket elevator.

It is important that the silo have adequate capacity to avoid any need for disturbing the ground storage pile except in emergency. In most cases, silo capacity should equal a 1-week supply of coal but no less than 100 tons. The emergency storage pile should contain a 1- to 2-month supply of coal in accordance with the prevailing national average for boiler-plant stock piles. Larger storage piles would be of little benefit since an industrial plant can hardly operate when its suppliers of raw materials are closed down because of a coal shortage.

Cylindrical steel bunkers and overhead steel or concrete bunkers often have been used in the smaller plants as a substitute for the silo, but at current prices, these bunkers cost from four to five times as much as concrete-stave silos and are usually too expensive to be considered a good application. Some types of overhead bunkers have the further disadvantage of causing a dust nuisance and of requiring that the size of the boiler-house be increased substantially. The cylindrical steel bunkers

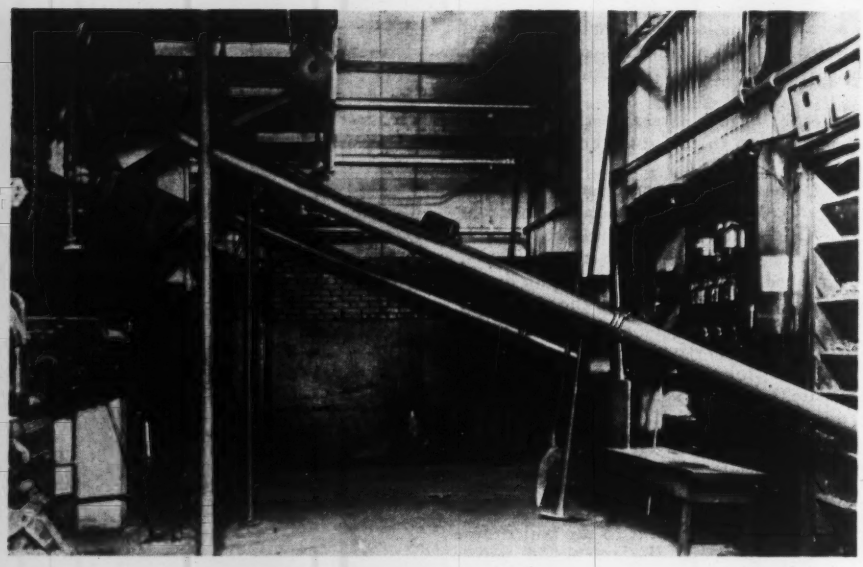

FIG. 7 BIN-TO-STOKER CONVEYER
(Courtesy Hager Bros. Company.)

are sometimes practical up to a 100-ton capacity where space conditions favor a roof location for the storage bin. Installed costs for all types of steel bunkers can be figured at about $100 per ton of storage capacity, whereas concrete-stave silos can be installed for between $20 and $25 a ton. Glazed-tile or monolithic-concrete silos cost from $40 to $50 per ton of capacity, but have little advantage over concrete-stave construction except in outward appearance.

SILO SYSTEM FOR 15,000-TON PER YEAR PLANT

A plant with a maximum steam load of 85,000 lb per hr and a 40 per cent load factor will consume approximately 15,000 tons

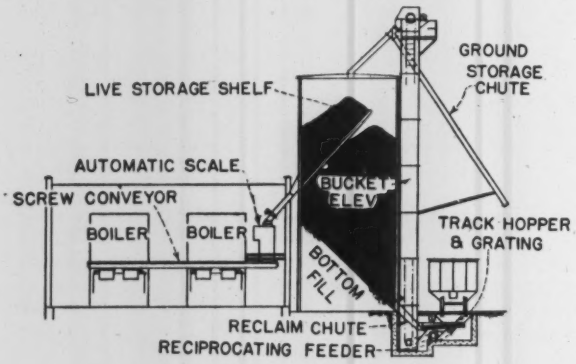

FIG. 8 PUSH-BUTTON SYSTEM FOR HANDLING COAL

per year or an average of 300 tons per week. A concrete-stave silo with 300 tons capacity, of which 20 per cent is on a live shelf, would cost $7500 erected. The unloading conveyers sized for 35 tons per hr would permit one-shift handling of more than four times the average daily coal consumption. The track hopper, feeder, and bucket elevator would cost approximately $12,000 installed. The screw conveyer would be sized for about 8 or 9 tons per hr (twice the maximum burning rate) and would cost from $3000 to $4000 installed. Adding $3000 for the automatic scales (one unit) and $2000 for a car shaker and car thawer, the total cost of the coal-handling system would be approximately $28,000.

Substituting a weigh larry for the screw conveyer and automatic scales, or simply using down spouts and Bailey coal meters from the silo to the stoker hoppers, would reduce the cost of the system by from $1000 to $4000. On the other hand, if an overhead bunker were substituted for the silo, the cost would be increased by $22,000 plus any extra building costs. Similarly, a skip hoist instead of the bucket elevator would add another $20,000.

COAL WEIGHING

The only purpose in weighing the coal at the plant is for measuring thermal efficiency. Unless steam flowmeters are provided, scales are superfluous. Whether or not scales are used, the monthly consumption of coal can be determined with reasonable accuracy from the record of delivered coal weights and adjusted for any change of the coal level in the silo at the beginning and the end of the month. Any movement to and from ground storage in an emergency could be measured separately.

COAL-STORAGE PILES

Double-screened sizes of coal may be stored indefinitely without danger of spontaneous combustion because there are ample voids to ventilate the storage pile. However, coals containing fines must be compacted carefully to eliminate any air pockets in the storage pile.

Since the emergency storage is seldom used, it is sometimes advantageous to store double-screened coal even though the plant may be burning slack sizes. If slack coal is stored on the ground, a bulldozer may be rented for compacting the pile, preferably one with caterpillar treads. The storage area must be well drained and free of combustible material such as paper, rags, grass, and wood. Then the coal should be compacted in layers of 8 to 10 in. in thickness until the desired height of pile

is obtained. Routine inspections should be made every few weeks for signs of "hot spots."

It is obvious from this discussion that slack coal might easily catch fire in a storage bin if left undisturbed. In the silo, Fig. 8, it is advisable to recirculate some of the coal from the reserve storage space every 2 weeks.

SPECIAL PROBLEMS

Arching Troubles. The arching of wet coal in storage bins and chutes is a problem to which some of the equipment designers have given very little attention beyond providing "poke holes" and vibrators for the boiler operator to use in case of trouble. The excuse that the coal is too wet is not valid because the handling system should be designed for the various coals that might be used rather than for some hypothetical coal that may or may not be economically available to the plant.

The scope of this paper does not permit adequate discussion of the arching problem, but any type of storage bin or chute can be designed to avoid such troubles. Vibrators and high-pressure air jets as well as "poke holes" can be provided for emergencies, but basically the designer needs to consider the following:

1 Discharge openings from a bunker or silo should have a minimum diameter of 10 to 16 in., depending on the maximum moisture content of the coal.

2 If the connecting discharge chute tapers to a smaller diameter, the effective opening from the storage bin will be reduced to the minimum cross section of the chute.

3 Overhead concrete bunkers in the shape of a "V" should not be used. There should be three vertical sides to such bunkers, whereby the column of coal over the discharge opening may slide down a vertical wall. The sloping side should make an angle of 45 deg with the horizontal, as steeper angles might cause a "wedging" effect at the discharge opening. In such cases, coal will not move freely down the sloping side; but this is of no consequence since the normal movement of coal will be vertically downward over the discharge openings. Coal on the sloping side will gradually shift in a downward direction sufficient to avoid spontaneous combustion. It is for these reasons that live-storage shelves and reserve storage spaces in silos are sloped at 45 deg.

4 Where it is desired to run a conveyer from the bottom of a storage bin, the conveyer should be as wide as the discharge opening from the bin, or a wide feeder should be used between the bin and the conveyer.

5 Gravity chutes should have a minimum angle of 60 or 65 deg from the horizontal.

Segregation Troubles. Another important matter which is very often neglected is the need to maintain a reasonably uniform mixture of coal size at the stoker hoppers. Hoppers wider than 15 or 18 in. should either be fed from nonsegregating chutes or should be provided with baffles to guard against one part of the stoker receiving all fines and another part receiving all coarse coal. Depending on the conveyer arrangement, the baffles should either split the falling coal stream into several equal parts or should provide that only one part of the hopper be filled at a time.

Bucket Elevator Maintenance. Bucket elevators have comparatively low maintenance but should be inspected regularly for signs of possible breakage of the chain or belt on which the buckets are mounted. Recovering all of these parts from the bottom of the elevator casing is a major undertaking, whereas all repairs otherwise could be made very quickly and inexpensively. It is also important to regulate the feed of coal to the bucket elevator so that the boot of the elevator will not become overloaded and cause damage to the equipment.

ASH HANDLING

Convenience in coal handling should take preference over ash handling because of the larger quantities involved. Hoist buckets and other portable systems are ideal for small plants. Pneumatic or hydraulic sluicing systems for ash disposal start at $12,000 erected. If the ash cannot be sluiced to a fill area, decanting tanks are required which make sluicing systems excessive in cost for the plant sizes under consideration.

Fig. 9 shows a pneumatic system with ash intakes in the operating floor directly in front of each ash-pit door, and fly-ash intakes at each fly-ash collector. The boiler operator can operate this system easily without assistance, including the raking of bottom ash to the intake openings. These intakes also may be located inside the ash pit or in the basement under a conventional ash hopper, in which case provision should be made for easily extracting and breaking up any large clinkers. An extra man would have to be available for any basement work during ash-removal periods.

Air flow in the disposal system is normally produced by a steam-jet ejector, so arranged as to prevent steam mixing with the ash and causing freezing troubles in the storage bin. Ahead of the steam jet is an ash receiver or separator discharging the ash to the storage bin. The exhaust from the steam jet is then

(*Continued on page 148*)

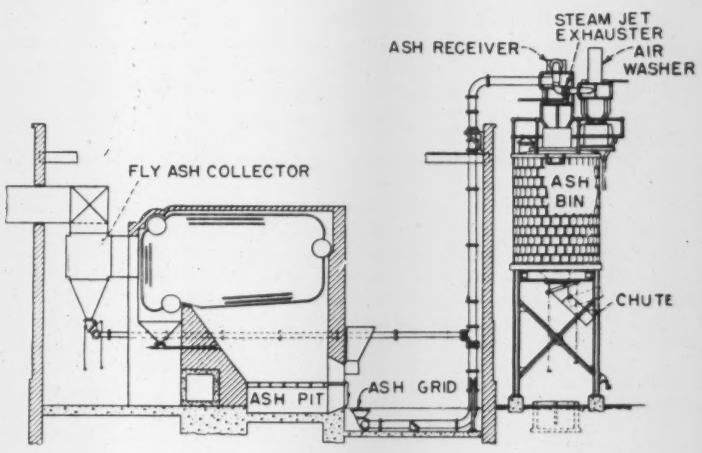

FIG. 9 PNEUMATIC ASH-HANDLING SYSTEM
(Courtesy National Conveyors Company, Inc.)

The Future of Automatic Machinery

By NORBERT WIENER

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THE gradual encroachment of automatic machinery on the function of mankind and its social significance is no novelty. For a considerable period toward the end of the past century Samuel Butler had been preaching that the machines were endowed with a sort of pseudo-life of their own, and that they were destined to develop this pseudo-life into a rather complete life, and to struggle with mankind for the control of human destiny. This was in a large measure intended as a figure of speech, even though it was expressed by a very imaginative and intuitive man, whose figures of speech possessed such vitality that they were often conjectural statements about the future rather than mere metaphors.

The remarkable thing is that at the time at which Butler was writing, and even at the much earlier time at which he was forming his ideas, machines were much less than they have since become, and were primarily devices for replacing human power and energy—mere extensions of his arms—rather than what they have since become; devices with a modicum of discriminatory judgment of their own. It is true that the seeds of modern servomechanism were already in Watt's ball governor for the steam engine, and that James Clerk Maxwell had given an adequate and very modern theory of this in 1868. It is also true that the beginnings of the technique of computing machines had existed for two centuries, and that Babbage had started an elaborate and flexible program of mechanical computation. Yet, neither the servomechanism nor the computing machine could be more than a sporadically useful device until the ripening of the modern techniques of electrical control and amplification, both dependent on the existence of such devices as the vacuum tube, with its simplicity of structure, its cheapness, and its extreme economy of power.

For it was just because of a lack of devices of those properties which the vacuum tube possesses, that the ambitious and mathematically well-thought-out attempt of Babbage came to grief. Babbage, for all his intelligence was not a mechanical genius. His apparatus consisted in long trains of gears meshing with gears; and the frictional forces were multiplied to such an extent that the device soon became too stiff to move. It is true that these difficulties can be overcome up to a certain point; and Pascal was already aware of this in the seventeenth century. It does not appear that Babbage was aware either of the extent of these difficulties or of the means by which they could be overcome.

The first really good tryout of long chains of control mechanisms dependent sequentially upon one another has taken place in the construction of high-speed digital computing machines. While the earliest models of these were primarily on a mechanical basis, they have been so far superseded in speed by electronic machines of comparable reliability that the mechanical devices, except for very special purposes, are on the verge of obsolescence. We thus possess a well-developed technique of devices which make yes-or-no decisions on the basis of previous decisions according to a scheme given in advance, and we must consider other devices of this sort as well within the range of possibility.

All this was not to be thought of at the time of Butler. It is only by a profound act on intuition that he was able to dream of what we may call the second industrial revolution; the revolution which replaces, not merely the human being as a source of energy, but the human mind as a source of low-level decisions, by manufactured instruments. I have commented repeatedly on the fact that the human brain also has an aspect, in which it seems to operate by decisions of a yes-or-no character, which are also based on previous decisions.

In calling the public attention to this very vital parallelism between the brain and the computing machine, I have opened a veritable Pandora's box. My statement has been interpreted as meaning, not only (as I have claimed) that we are within measurable distance of the automatic factory, in which the functions of the routine worker are taken over by electronic devices, but that we are in sight of a new era, in which the translation from speech to writing, the translation from writing to speech, the translation from one language to another, and the functions of the file clerk and librarian, and of other custodians of information, which is to be made readily available to all, shall take place without human intervention.

In this expectation, I think that our gadget-conscious public has shown an unawareness of the special advantages and special disadvantages of electronic machinery, as compared with the human brain. The number of switching devices in the human brain vastly exceeds the number in any computing machine yet developed, or even thought of, for design in the near future. The volume of the smallest tube is millions, or even billions the volume of a neuron; and the neuron probably represents far more than a single switching device. Even when the transister is so perfected that we can make a satisfactory computing machine out of transisters instead of vacuum tubes, we shall still be far from the compact and manifold complexity of the brain. On the other hand, the vacuum tube already has far outstripped the corresponding nervous mechanism in speed, and probably in reliability of action. This power of the vacuum tube to work on a time scale much smaller than that of the brain, gives back to the computing machine a measure of the efficiency lost by its coarser spatial grain.

There are certain parts of a computing machine in which we do not yet see how we can buy the equivalent of its spatial inferiority by paying for this with its advantages in speed. Computing machines and brains alike store information; but the storage of information in the best computing machine yet thought of does not compare with that of the brain. Thus the brain is at its best in the performance of operations involving a great deal of stored information and a very complex synthesis of this information. The computing machine or factory-control machine, on the other hand, is at its best in the speedy and accurate performance of relatively simple operations.

It might be thought that the complexity of the process of memory and cross reference involved in the most precise and rigid thinking in action would be greater than that involved in our everyday speech. I do not believe this to be the case. The success of the computing machine in the treatment of arithmetic is in supreme contrast to our failure to reduce moral and

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aesthetic judgments to any simple method of coding. Such a book as "The Aesthetic Measure" by the late G. D. Birkhoff shows the feeble success of one of the greatest analytical minds in accomplishing the rudiments of this task. To be an art critic requires a vast array of cultural experience, historical knowledge, and emotional scope and integrity. The number of yes-and-no decisions before it is possible even to begin such a task is so enormously greater than the number of yes-and-no decisions for the postulates of a very complicated mathematical system, that all comparison is utterly ridiculous.

Thus the precise and accurate can be cleared up with one or two statements, whereas the vague and emotional needs the whole experience of a lifetime to evaluate with any authority. Such a simple statement as "John is a good man" cannot be made by anyone who has not wide experience of people. What we ordinarily take to be the translation of this into another language will very seldom answer to the same experience in all respects. We shall ordinarily say that "a good man" and "ein guter Mensch" mean the same thing; and they do in so far as any equivalent is possible between words based, respectively, on the mores of England and America on the one hand, and of Germany and Austria on the other. Yet these mores, similar as they are, are not identical; and a storage of the whole code lies behind the corresponding word.

Here I have taken two words which translate into each other as precisely as two words can. In the average case the translatability of words from one language into another is much less. Who has not sought for an English equivalent of "gemütlichkeit" or for a German equivalent of "fair play?" The very fact that English borrows a word for justice from the milieu of the athletic field is significant; and while it may be understood generally in the athleticized world of the fifties, it could not have had its full meaning on the continent of Europe in the middle of the nineteenth century.

I cannot see, then, that the machine for the translation of one language into another is imminent. I cannot even see that we are near a machine, which will take in spoken language and give out a typewritten text, or vice versa. These machines would be extremely useful, one for the deaf and one for the blind. Those who are very sanguine about the immediate future of these machines do not realize that written and spoken English are never exact equivalents of one another. Quite apart from the idiosyncracies of English orthography and pronunciation, there is no very precise code by which the separation of words in printing, the use of punctuation and capitals, and the other devices at the disposal of the writer or typist, can be made equivalent to the timing and intonation of speech. In general the correspondence between speech and writing must go through an understanding of the meaning of the written or spoken language.

Translation machines of any of the sorts mentioned (except in a very rudimentary form) are thus rather remote. They involve the transferrence to machinery of human values, human characteristics of learning, and the like, and thus involve the attempt to replace the brain by the machine just where the brain is at its best and the machine is at its worst. I do not doubt that the machines can be made to learn, and even to evaluate, but to make them learn and to evaluate after a specifically human pattern involves much more precise knowledge of the human system of evaluation and the human methods of learning than, I imagine, is now in the hands of the constructors of cybernetics machines—or indeed, of anyone else.

These same difficulties will militate against the perfection of the art of cataloguing and cross-reference-making by machine, which has been much touted for some years in some influential quarters. It is not difficult to search for the affinities of an article, when one classification has been given, *and the affinities of this classification are already recognized*. However, the first true recognition of the affinities of different subjects often requires an intellectual effort of high order. For example, it is not difficult to be aware that mathematical epidemiology and the kinetic theory of gases have much in common, once the similarity has been pointed out; but it is too much to ask of any extant machine, or any to be expected in the near future, to recognize this similarity before it has been pointed out. In searching the literature for such similarities, it is much better to recognize that an author is likely to use the same kit of tools in different subjects, and to link up all the writings of the authors who have written on one of these subjects, with a critical eye to the idea structure of their writings, than to depend on an existing subject index, no matter how elaborate. A mechanical cataloguer will long remain as inferior to the expert human cataloguer with scientific knowledge, as a peg-leg is to the flesh-and-bone article.

I bring up these shortcomings of the linguistic and intellectual use of manufactured apparatus, just because I wish to define and mark off these fields in which mechanical apparatus is already the competitor of the human worker, or threatens to become the competitor in the near future. The steam engine soon became the competitor of the galley slave, just because the galley slave was being used in a most uneconomical manner, as a source of power and scarcely anything else. There still exist factory tasks in which human beings are used for discrimination instead of for power, but in which this discrimination is on such a low level that it represents an employment of human faculties almost as imperfect and uneconomical as that of the galley slave.

It does not require the full complexity of the human organism to paste labels on tin cans, nor to sort and pack spears of asparagus. It does not require the full complexity of the human organism to read the instruments in a chemical factory, and to turn switches or valves in accordance with a code determined by their readings. It does not even require a very high and human type of labor to turn a wrench and tighten one or two bolts per car in an assembly line. In all these cases, the overdesign of the human mechanism used is as gross as if we were to adjust the degree of opening and closing of a barn door by an interferometer.

In a factory in which the greater part of the employees perform routine tasks, and management pays attention solely to technical operations, there is a great analogy with the team of semiskilled computers presided over by a mathematician. The mathematician sets up the problem, determines the routine for its solution, divides this routine into parts which can be performed by computers whose only talent is reliability without a trace of originality, and stands by to see that any defect in method or performance is rectified.

The analog of the mathematician in the case of such a factory is the "efficiency expert" of old disrepute who decides on the general pattern of work, divides up the individual tasks, determines for each worker the sequence of motions and decisions which will accomplish these tasks most effectively, and stands by to see that his orders are fulfilled, and that in case of any error or inadequacy, they are modified in the proper sense. The employees of such a factory are even less skilled than the routine computer. They come to their work as whole human beings, but they are used only as effector organs of the superhuman mechanism with its brains elsewhere in the organizing staff. They eat and drink, love and hate, enjoy and tire, like other human beings, but from the point of view of their job alone, these outside faculties and necessities of their lives are nothing more than so much tare, so much useless baggage, perhaps inseparably connected with the pair of hands for which the employer pays, but of no direct value to him. Thus the question

of replacing these workers by automatic machinery is not the question of replacing so many men, but rather half-men or quarter-men or even hundredth-men.

Under these conditions, the machine which performs tasks laid out without any regard for the psychological and sociological aspirations of man, could become a real competitor of the human worker. If the human worker is left only the rudiments of discretion in his choice of the method of performing his task, he is only the equivalent of the machine, and he is far too complicated and exacting a machine to compete with the glorified computing machine. In fact, the situation is just the same as that found in mechanical computation. At the low level of the repetitive tasks constituting the greater part of factory work, speed of performance and a high measure of unvarying accuracy are worth more than complexity. Thus, from the limited standpoint of expenses within the factory, automatic machinery is bound to encroach more and more on the individual workman.

From this fact it has become fashionable for purblind gadgeteers of a certain type to draw very false and dangerous conclusions. I have heard of an article soon to appear in a magazine belonging to a great syndicate of periodicals in which the claim is made that the machine is rendering the human being obsolete. This view is a grim reminder of errors of the past. It neglects the work of such management leaders as Gantt and the Gilbreths who long ago admonished business against a lack of "heart, sense, and feeling," and provided techniques which took cognizance of the potentiality and dignity of man's hands and, above all, of his brain. The ill-famed "efficiency expert" has given way to the professional motion-study engineer, and the slave-driving supervisor is replaced by professional managers.

The automatic factory, so much more complicated than any less mechanized industrial organization, demands managerial personnel who recognize their social responsibilities as well as their economic responsibilities. Today progressive management thinking denies that man himself is becoming obsolete wherever the machine supersedes him in the routine performance of routine tasks.

Behind this evaluation of the future of the machine lies an evaluation of man which, in my mind, is the sin against the Holy Ghost. Routine tasks lose all significance except in so far as they accomplish something for mankind: The railroad and steamboat exist to transport man and the materials necessary for his subsistence; the cotton field and textile factory to enable him to cover and shelter himself; the grist mill and wheat field to keep him from hunger.

Those who value man not in his own right but merely as an instrument for production see eye to eye with the slave merchant and the Egyptian gentleman who squanders at Monte Carlo the moneys earned by his fellahin in the sweat of his brow. This evaluation of man is that of Fascism, of the attitude that I am one of the privileged élite, and that the common man exists for nothing but aggrandizement of this élite. Those who devaluate man in the presence of the superior efficiency of the machine, are simply those who have already devaluated man in their own hearts, and their works speak for them.

Those such as Samuel Butler, who have foreseen the triumph of the machine over mankind, have pointed to a very real danger, but often to one which they themselves have but imperfectly understood. They have made of the machine an independent and autonomous enemy of humanity, like the tiger that lies in wait for us, or the spirochete that rots our vitals. Yet the range of our enemies contains others which are in great measure the images of our own inner defects and inadequacies. The cancer cell is an intrinsic part of our bodies, flesh of our flesh, blood of our blood, bone of our bone, which represents an inner defect of our own construction, a demon already implicit in our own make-up. A virus may be a complete organism, an invader from the outside, but it may just as well be something like a gene, something between a chemical substance and a true organism, which can only reproduce itself by a perversion of our own metabolism, which renews the substance that has caused its perversion.

Thus the machine, for all the similarities that its functioning shows with that of the human organism, is at a much lower level of organization and complexity; and the dangers it offers to humanity are not those of an independent will and purpose of existence, but merely those of a material embodiment of our own stupidities and shortcomings. If we rate a man only as a factory hand, for the cost of his daily wages, then the machine will indeed displace man over much of his range of activity. But in essence, the factory hand is first a human being, and only secondarily a factory hand. In essence, production is merely a device to provide for consumption. Life is more important than toil, which has the primary function of providing the wherewithal for life. The danger of the machine is already implicit in the scorn of the self-appointed élite for the great body of humanity, which has expressed itself as Fascism, and may choose as a vehicle other forms of totalitarianism. It is this already existing ruthlessness which threatens to call the machine to its aid as an ally against the vast body of humanity and which in doing so threatens to cut off even its own reason for existence.

If we accept the primacy of man over his means of production, there is no reason why the age of the machine may not be one of the greatest flourishing of human prosperity and culture. Prima facie, plenty is a good thing, provided that it does not become a mere fetish like the potlatch feasts of the North Pacific Indians, and a mere vehicle for power, prestige, and ostentation. This does not mean, however, that this golden age of plenty will come without problems, and even dangers. Leisure must be recognized as a good thing, more especially in the opportunities it offers for a fuller life and a greater scope for the human urge to create. It must not be permitted, however, to degenerate into nothing but the universal distribution of *panem et circenses*, or bread and the prize fight, the cheap Hollywood movies, and the inspired twaddle that tends to invade all literature. Most of all, it seems that the routine work of the factory, although it exists primarily for the sake of the material products produced, does fulfill for certain persons a demand for the self-respect of useful employment, even as the jails fulfill for some persons the need of a sense of atonement.

However, to say that the automatization of industry may bring in its train social problems not easy of solution is not to say that these problems are intrinsically not solvable except through the present factory system. The curse of Adam is old, but it has only exhibited itself for a century and a half or so against a background of wheels and pulleys. It represents a bankruptcy of imagination to say that it must forever show itself against the same background.

The forms of social organization are manifold. One experimental new form, that of orthodox totalitarian communism, is now under a great cloud in so far as the official and the popular attitude of the greater part of the Western world is concerned. This does not mean, however, that we are under any compulsion to fix the present practices of the Western world as something unquestionable and immutable. The chief revolution of the present time is not one of social dogmas, but of industrial techniques and practices. If we approach the difficult problems of the near future with our arms bound in a straitjacket, we shall perish, and we shall deserve to perish. Yet it is highly likely that with a little freedom of action, we shall find the future livable, and even full of hope.

THE ASME BOILER CODE

VI The Great Years—1928–1931

By ARTHUR M. GREENE, JR.

PRINCETON UNIVERSITY, PRINCETON, N. J. HONORARY MEMBER ASME

THE years 1928–1931 mark the final approval of autogenous welding, now called fusion welding, for the shells and parts of pressure vessels and also for power boilers, low-pressure heating boilers, and miniature boilers after long years of endeavor to satisfy demands of boiler fabricators. They are also great years because of the inauguration of the work on rules for dished heads which had existed for twenty years and for the bringing together in one part of the Code the old and new rules for the sizes of unreinforced openings, threaded connections, and nozzles, and the new formula for flatheads.

This slowness in the full recognition of fusion welding was not caused by any objections of the Committee to changes in the rules but solely because it did not know how to form rules for safe welded vessels when the advocates of different methods of welding could not agree on rules to produce reliable structures. The steps taken and the contributions of different organizations in them will be discussed under the heading of Fusion Welding.

In 1930 new editions of certain sections of the Code were produced from the addenda published between the last printings and the times of printing the new editions. These were: Section I, Power Boilers; Section II, Material Specifications; and Section VIII, Unfired Pressure Vessels. In Section VIII the "Recommended Procedure for Fusion Welding of Pressure Vessels," placed in the Appendix as Pars. UA-10 to UA-21 (8 pages), was that upon which the Committee based its belief in safe construction; and in reality it was the dawn of a new day for vessel construction under the ASME Boiler Code.

The 1927 edition of Section I, Power Boilers, Section II, Material Specifications, Section VI, Rules for Inspection, and the Appendix were published in one volume from addenda to the 1924 editions of those sections as noted in the previous chapter. It was approved by the Council on Dec. 6, 1926, and April 4, 1927.

This was signed by 25 members of the Boiler Code Committee. The new members were H. E. Aldrich (Scotch marine and other types of boilers); Frank S. Clark (boiler users); William F. Durand (engineering education); Vincent M. Frost (boiler users); Frank B. Howell (cast-iron heating boilers); J. O. Leach (boiler-plate manufacturers); James Partington (railroad boilers); C. L. Warwick (ASTM), and H. LeRoy Whitney (pressure vessels). The Committee had lost from its membership of 1924 by death or resignation, N. A. Carle, Frank H. Clark, Elbert C. Fisher, W. F. Kiesel, Jr., W. F. MacGregor, Wm. B. Reed, and H. H. Vaughan. The Conference Committee was increased to 36 by the addition of one member from Tulsa, Okla., a new municipality which had adopted the Code.

The former numbering of paragraphs was continued in the 1927 edition and the principal addenda covered the following: The elimination of the flattening, crushing, and bending tests for round or square tubing when used for sinuous headers; the increase in the corner radius of unstayed dished heads; the permission for the use of attachment of stays below the tubes at the rear heads of HRT boilers; the increase of safety-valve relieving capacity from the addition of water screens or waterwalls; and details of water glasses, cocks, and steam gages as well as stop valves and water columns. Provision was made for the proper testing of universal or end-rolled plates when used for double-butt-strap construction. Double-extra-heavy pipe details were given in the material specifications. In Section II many of the material specifications were brought into agreement with ASTM specifications and the following three specifications were added: Carbon-Steel Castings for Valves, Flanges, and Fittings for High-Temperature Service; Carbon-Steel and Alloy-Steel Forgings; and Seamless-Steel Drum Forgings.

In 1928 a single volume containing all sections of the Code was published but it was still called the 1927 edition. It contained 394 pages of text with complete index of 48 pages. It listed another municipality, Omaha, Neb., which had adopted the Code. The addenda published before the time of printing were included as well as the specifications for Steel Plate for Forge Welding and Brazing.

During these four great years the Committee held an average of nine meetings per year with an attendance of 14 members and also three from the Conference Committee, three from the Subcommittees, and seven invited guests. There were 129 cases considered, Case 576 to Case 704, an average of 32 per year. At many if not all of the meetings, revisions were considered and some meetings were devoted solely to this activity, as this was a period of great development in which the excellent extra work of the Executive Committee expedited that of the main committee.

FUSION WELDING AND FORGE WELDING

The revised and less extensive program for the testing of welded tanks at the Bureau of Standards, reported in the last chapter, required approval of the ASME. A letter was received on Oct. 18, 1927, from Eric H. Ewertz, chairman of the Pressure Vessel Committee of the American Welding Society, regarding this revised plan and asking approval. This letter was not answered until after the Committee meeting of Jan. 13, 1928, as the Committee, although approving and realizing the importance of the tests to engineers and fabricators as well as to users, believed that a method of procedure in forming welds and the inspection of them was as important as the knowledge that safe welds could be made.

This belief was shared by all the members of the Boiler Code Committee and its Subcommittees on Welding, on Unfired Pressure Vessels, and on Heating Boilers.

Chapter 6 of a history of the ASME Boiler Code, prepared for the Boiler Code Committee of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Chapter 1, which dealt with the antecedents of the Code, appeared in MECHANICAL ENGINEERING, July, 1952, pp. 555–562; Chapter 2, which told how ASME set up the Committee and adopted the first Code of 1914, appeared in August, 1952, pp. 640–66; Chapter 3, which dealt with the administration of the first Code from 1915–1918, appeared in September, 1952, pp. 727–734; Chapter 4, describing how ASME expanded the Boiler Code from 1919 to 1924, appeared in November, 1952, pp. 897–907; and chapter 5, covering the administration of the Power Boiler Code from 1925 to 1927, appeared in December, 1952, pp. 996–1004.

To one member, Samuel Wylie Miller, rules of procedure were paramount. For years Mr. Miller, as the founder of the Rochester (N. Y.) Welding Works, had been a manufacturer of welded tanks and had perfected manufacturing methods for safe work. He was probably one of the first to visualize the possibilities of welding. In 1923 he was a member of the Pressure Vessel Committee of the American Bureau of Welding that conducted the extensive tests at the U. S. Bureau of Standards. Later he joined the Carbide and Carbon Research Laboratories, Inc., to carry out research on welding. It was he who went to California in 1927 for the Boiler Code Committee to aid in the work of the Industrial Accident Commission of that State in formulating its Air Pressure Tank Safety Orders as discussed in the previous chapter. He also advised the Boiler Code Committee in its extensive correspondence with E. G. Sheivley, chief engineer of the Commission.

The orders of California had called for the training of welders and provided for supervision of this work, a subject of interest to him.

At the convention of the International Acetylene Association on Nov. 11, 1926, Mr. Miller presented a paper, "The Most Important Thing in Welding." In this paper he pointed out that the manipulation of the welding blowpipe was different from that of a lathe or other machine tool but the same principle that procedure must be correct underlay both operations. This procedure consisted of six elements: design, materials, methods, operators, supervision, and tests. Such procedure control in welding, he stated, had shown its value in many cases not only in better work but in reducing costs and increasing production. Design should be such as to weld easily and cheaply and produce good work. Some designs for other forms of joints than welded joints were frequently not suitable for welds. Materials for the base metal and the welding rods must be suitable for sound welds. Good methods required jigs, fixtures, clamps, and other tools. The operators although necessary were not more important than the other five elements. Supervision was most important and the testing of operators and product was a requirement.

FUSION WELDING

During this period of work with the laboratories and with the various Subcommittees of Welding and Unfired Vessels, Mr. Miller suggested that the term autogeneous welding be changed to fusion welding. This term was then adopted for the new edition of the sections of the Code.

RECOMMENDED PROCEDURE FOR FUSION WELDING

At the Committee meeting of Jan. 13, 1928, Dr. D. S. Jacobus, chairman of the Executive Committee, reported that it had considered the approval of the tests proposed in the letter of Eric H. Ewertz of Oct. 18, 1927, and he also presented a draft of a Recommended Procedure for Fusion Welding submitted by C. W. Obert. He suggested that the reply of approval to Mr. Ewertz include the submission of this draft for the criticisms and suggestions of the Pressure Vessel Committee of the American Welding Society, as it contained what the Committee had desired for a long time. This was sent for consideration with the reply approving the reduction of the number of tanks to be tested and suggesting that the breathing tests be conducted with alternating pressure from near zero to 50 per cent above working pressure, giving a stress variation from as near zero as possible to 12,000 psi. The letter also stated that the Boiler Code Committee had under consideration formulas covering dished heads which would provide heads of greater strength than those now required by the Code and that these would be available soon so that heads of this design might be included in the test.

The Recommended Procedure of Fusion Welding of Pressure Vessels followed so closely the outline of the paper of S. W. Miller in 1926, "The Most Important Thing in Welding," that it must have been produced by the group in the Carbide and Carbon Research Laboratories, some of whom were: C. E. MacQuigg, S. W. Miller, A. B. Kinzel, and C. W. Obert. Since his connection with the Carbide and Carbon Research laboratories, Mr. Obert had been engaged in conducting bend tests on welds for its investigations.

The recommended procedure was intended for application to a vessel to conform to the requirements of the ASME Unfired Pressure Vessel Code but applicable in general to all fusion-welded pressure vessels as stated in the explanatory note on page 1 of this procedure. This was followed by Section 1 on Materials (one page), which required plate steel as given in Pars. S-5 to S-17 of Section II of the Code, or Pars. U-110 to U-125 of Section VIII, while deposited metal should have given qualities and conform to American Welding Society Specifications El-A, El-B, or Gl-A.

Section 2, Design and Construction (4 pages), required the design to conform with the Unfired Pressure Vessel Code and the construction to be witnessed by an authorized inspector. The method to be used in fabrication was given next, including the forming of welded joints and the attachment of the heads.

Section 3, Qualification Tests of Welders (4 pages), was for the purpose of (1) demonstrating that the welder knew how to handle the apparatus and to secure good penetration and fusion, and (2) determining the general character of welds and that of the material used. The tests for gas welding and for arc welding were defined and then a qualification test was described and its requirements defined.

Section 4, Supervision (1 page), related to the duty of management to insure the proper materials, design, and construction and to provide properly qualified welders to give sound and safe welded construction so that the requirements of the Code might be fulfilled.

Section 5, Inspection (3 pages), referred to the requirements of Par. U-65 of Section VIII of the Code for inspection by an independent inspector of a state, municipality, or an insurance company. This inspection was described.

Section 6, Testing (2 pages), referred to the hydrostatic tests in Pars. U-65 and U-76, and gave detailed instructions for the steps in the testing of the finished structure.

A sheet of drawings gave the dimensions of various test pieces and the manner of dividing them as well as the method of holding the parts to be welded.

The American Welding Society appointed a Committee on Welding Code for Pressure Vessels to study the recommended procedure for fusion-welding of pressure vessels. This was reported on April 13, 1928. The committee consisted of C. W. Obert, chairman (Union Carbide and Carbon Research Laboratories), G. R. Brophy (General Electric Co.), L. H. Burkhart (Struthers Wells Co.), A. M. Candy (Westinghouse Electric & Manufacturing Co.) John J. Crowe (Air Reduction Co.), Herbert H. Moss (The Linde Air Products Co.), and James W. Owens (Newport News Shipbuilding and Dry Dock Co.).

The report of this committee was submitted by the American Welding Society on Feb. 8, 1929, and referred to the Subcommittee on Welding. It was reported by it to the Boiler Code Committee for adoption at its meeting of April 19, 1929. This report was referred to the Executive Committee for study and with power to authorize its publication in MECHANICAL ENGINEERING. The Committee also voted to amend Pars. U-23 and U-68 so that when vessels were fabricated in accordance with the recommended procedure for fusion-welding of pressure vessels as published in the Appendix, the limiting diameters of Par. U-23 (a) might be taken as 60 in. and the

limiting pressure might be taken as 200 psi, provided the temperature did not exceed 250 F. Under the same conditions the maximum working stresses of Par. U-68 for the strength of joints might be taken as 8000 psi for double-V-butt longitudinal welds, 6500 psi for single-V girth butt or head welds, 7000 psi for double full-fillet lap or girth welds, and 5600 psi for spot or intermittent girth or head welds.

This revised Recommended Procedure for Fusion Welding of Pressure Vessels covered the same subjects as those submitted to the committee of the American Welding Society in April, 1928, separating design and construction into two sections and thus having seven sections in all. Materials for manholes, nozzles, and other connections were added to materials and the sections on design were enlarged. Local inspection was included as part of the section on supervision. The various sections were made somewhat fuller, but the intent and content remained as originally given in the draft submitted by C. W. Obert.

STRESS IN WELDED JOINTS

On May 11, 1928, S. W. Miller presented to the Committee a paper on a method of determining the allowable stress on a welded joint by the results of a bend test and a tensile test on parts from materials used under practical working conditions. This paper was published in MECHANICAL ENGINEERING. The formula for this stress had been deduced by A. B. Kinzel of the laboratories from the study of the results of a number of tests. In the formula

$$S = \frac{T}{7.15}\sqrt[3]{\frac{E}{10}}$$

S was the allowable working stress, psi; T was the ultimate tensile strength, psi; and E the percentage elongation determined by the bend test. Although this formula received much discussion it was not used in the Code.

PROGRESS OF TEST PROGRAM

On June 15, 1928, Eric H. Ewertz, chairman of Joint Research Committee on Welding of Pressure Vessels, asked for the assistance of the Boiler Code Committee to secure the co-operation of tank manufacturers in inaugurating the proposed tests. He desired suggestions or assistance in getting more tanks and funds for this work. Dr. Jacobus stated that the manufacturers did not see why the tests were needed. As soon as the Code and the procedure were published as planned, he said, the manufacturers, if told of the test needed to show the safety of the procedure, would give support. However, support did not come at that time and on Dec. 3, 1928, a letter was received from the secretary of the Joint Committee which stated that again the scope of the program had to be reduced to cover only thicknesses of $\frac{3}{8}$ in. and $\frac{3}{4}$ in. with 72 tanks in all, in place of the original 700 to 800 tanks.

On April 19, 1929, W. Spraragen of the Committee on Tests reported that he had secured the co-operation of eleven companies by the promise of tanks and possible funds amounting to $10,000. The Joint Committee had seriously considered dropping the program because of the lack of co-operation, but it believed the publication of the new Code might affect the demand for the tests and that the needs of the pressure-vessel industry should guide any future action.

TESTS OF THIN TANKS

In a letter of Dec. 2, 1930, W. Spraragen reported on tests of pressure vessels of light gage fabricated by a resistance-welding process. These tests, made at the request of the Joint Committee, were conducted at the Fritz Engineering Laboratory of Lehigh University by W. A. Slater and M. O. Fuller under the supervision of the Executive Committee of the Joint Committee.

There were seven tanks, 12 in. in diameter and 4 ft in length, of No. 11 gage metal (nominal 0.125 in.) with heads of No. 9 gage (nominal 0.156 in.). These tanks were made by the John Wood Manufacturing Company of Conshohocken, Pa., using their electric-resistance compression butt-weld process. This weld was made by a continuous current while compressing the edges progressively as the metal came into a plastic condition. The preformed convex or concave heads were driven or forced into the shells with a driving fit and thoroughly welded. The method was carried out in accordance with a set of rules prepared by the John Wood Company describing the materials for shells and heads and their composition, ladle analysis, check analysis, annealing of sheets before forming, tensile test, bend tests, number of tests, test coupons, and stamping.

Six of the tanks were tested under hydrostatic pressure and the seventh was cut to obtain test coupons. Tanks 1, 3, and 5 had convex heads on each end while 2, 4, 6, and 7 had a convex head on one end and a concave head on the other. Each tank had two openings for 1-in. pipe in welded bushings, one in the shell and the other at the center of the convex head.

Seventeen 12-in. tension-test coupons were cut from tank No. 7, each $1\frac{1}{2}$ in. wide for 8 in. at center and 2 in. for the remainder of length. Twelve of these, A1 to A12, were cut so that the welds came at the center of the length and the other five, B7 to B11, were cut from the unwelded plate. A1 to A7 had a varying number of $\frac{1}{16}$-in. holes drilled through the welds to secure rupture at the weld. Some of these coupons broke at the weld, while in the case of the undrilled coupons, A8 to A12, all ruptures were outside the welds. The strains were about twice as great in the welded coupon. The average strength of the specimens which broke in the plate was 54,500 psi with a yield point of 41,200 psi. Of the four specimens containing nine drilled $\frac{1}{16}$-in. holes three broke in the plate, showing that the strength of the plate and that of the reduced length of welds were about equal. This indicated that the weld was 60 per cent stronger than the plate. The strains indicated that the modulus of elasticity was 25,000,000 psi for the plate and about 15,000,000 psi for the welds. During the hydrostatic tests of the tanks to rupture, strains were measured by an Olsen strain gage and by a Huggenberger tensometer; measurements were taken longitudinally and transversely. Changes in diameter and angular distortion of the transverse welds and the deflections of the heads were measured. On the release of pressure the permanent sets at different points were measured. During the tests the tanks were hammered at several pressures by a $1\frac{5}{8}$-lb hammer using blows that sometimes dented the plate. Only one tank failed on a longitudinal line of the plate at 1195 psi pressure with a stress of 37,300 psi. Two tanks failed at the convex ends by leakage at the weld, while with the three which failed at the concave end there was a bulging of the head followed by rupture in the transverse seam. The pressures at failure were 600, 860, 740, 1075, and 760 psi for the five tanks failing.

The letter in which these tests were reported was accompanied by four recommendations for changes in the Code for the use of this type of welding for plates of not over 0.135 in. thickness using compositions called for in the rules of the John Wood Company and also the figures of welds for those rules. The letter included in addition the record of pulsation tests of longitudinal seams of electric-resistance compression butt weld of four tanks (12 × 48) of 0.101-in. shells and heads of 9-gage metal. The longitudinal seams showed no signs of failure after 212,940 pulsations in $272\frac{1}{2}$ hr for tank No. 1; 308,880 in 396 hr for tank No. 2; and 306,540 in 393 hr for tank No. 3.

Tank No. 4 was still under test when it had been given 92,560 pulsations in 118 2/3 hr.

Although the tests of the John Wood Company tanks did prove the reliability of the method and the Committee had prepared paragraphs to include this method of welding in the Code, these were not adopted during this period of activity.

ELECTRIC METHODS OF WELDING

The Murray method of high-current pressure welding and the arc-welding method of the Petroleum Iron Works Company, described by E. E. Shanor with their rules of procedure, presented in the last chapter, were considered during this period but no rules were formulated for them. The patented arc-welding method of A. O. Smith Corporation, described by Dr. T. McLean Jasper, director of research, on Jan. 10, 1929, was considered also by the Boiler Code Committee throughout this period, but because of its special patented nature it was not possible to include it in the Code. Dr. Jasper gave an extended discussion of the physical and chemical properties of the Smith welds and the application to many vessels in the oil industry but declined to give any technical information of their patented method of welding. He gave the method of calculating the strength of their welds at normal and elevated temperatures. Walter C. Ross, an officer of the A. O. Smith Corporation, recommended that the Committee formulate rules to test tanks rather than those covering methods of welding. Dr. Jasper was appointed a member of the Subcommittee on Welding at this meeting.

FUSION-WELDED BOILERS

In August, 1929, Messrs. Fish and Obert visited the plant of the A. O. Smith Corporation and discussed a specification for welded pressure vessels. At the meeting of the Committee on Sept. 20, 1929, E. R. Fish presented a tentative specification for welded steam boilers covering materials, factors of safety, welded boiler drums, construction, unit working stress, qualification of process, testing, and acceptance of vessels. This had been submitted to the Smith Corporation and was discussed by the Boiler Code Committee.

REPEATED STRESS TESTS—FUSION-WELDED BOILER DRUMS

On Sept. 20, 1929, the Committee received from Dr. D. S. Jacobus of The Babcock & Wilcox Company a specification, developed from the work of Isaac Harter, Jr., Dr. J. O. Hodge, J. E. Trainer, and H. J. Kerr, for Electric Arc Welding of Pressure Vessels, together with a reprint of a paper from *Iron Age* of Sept. 5, 1929, describing the tests of drums fabricated according to these specifications and to others fabricated with riveted seams each under repeated stress. The specification included the use of steels for arc welding called for in the ASME Boiler Code. It called for two sets of test plates and their formation, annealing to at least 1200 F, tension test, bend test, impact test, chemical analysis, macro and micro test, retests, nondestructive test, fatigue tests, holes, and allowable working stress (8500 psi).

The extensive tests mentioned proved and justified the new specification for fusion-welded boiler drums. They were planned and the apparatus designed and developed by the laboratory force of the Barberton Plant (Ohio) of The Babcock & Wilcox Company under the able and continuous direction and supervision of Isaac Harter, Jr., with H. J. Kerr. The paper describing this work was written by Prof. H. F. Moore, of the University of Illinois, its consultant in the conduct of fatigue experiments, his specialty. The tests were made on seven full-size boiler drums and shells, 3 ft to 3 1/2 ft inside diameter. These were: a manganese-steel drum, riveted, 1 in. in thickness; an ASME Standard riveted drum, 2 in. in thickness; four arc-welded shells A, B, C, and D, 2 in. in thickness; and a forged-steel shell, 1.875 in. thick. The efficiencies of the riveted longitudinal joints were 71 per cent for the first drum and 80 per cent for the second, while the arc welds and forged joints were considered to have efficiencies of 100 per cent.

These vessels were equipped with Berry strain gages, dial gages, and Bourdon gages to measure strains and permanent distortion at different pressures. The first two drums were of standard form with dished heads and manholes, while the five latter structures were merely shells to which hydraulic pressure could be applied.

The manganese steel of 83,000 psi yield point and 106,500 psi ultimate strength, 16 per cent elongation with 36 per cent reduction in area contained 0.29 per cent C, 1.95 Mn, 0.025 Ph, and 0.036 S. The other vessels were of ordinary carbon-steel plate of Code requirements.

There were six repetitions of stress per minute in the tests with the pressure varying from 0 to 150 per cent of the working pressure, 0 to 1260 psi pressure on the drums and 0 to 1570 psi for the shells. Only one of these specimens ruptured in the shell. The first drum failed in the drum head after 130,225 repetitions, and the second after 1,013,840 repetitions had no failure. The first shell failed at the seam at 5530 repetitions. This was hand-welded with uncovered wire electrodes. The second shell failed at the 1/2-in. tapped gage hole after 417,381 repetitions but not at the weld. This was hand-welded with covered electrodes. The third shell failed at the 1/2-in. tapped gage hole after 561,984 repetitions. This was hand-welded with covered electrodes. The fourth shell was a duplicate of the third shell and failed the same way after 435,883 repetitions. The fifth shell, a forging, failed at 1/2-in. tapped gage hole after 446,950 repetitions. These five shells were under almost pure hoop tension as the head loads were carried by bolts. The failure at the tapped gage holes in all cases indicated stress concentration due to the holes but in all but one of the shells the repetitions were probably 50 times the expected repetitions in the life of such boiler structures. This test and the specification led to Pars. P-100 et seq on the fusion welding of boiler shells. This was first approved on June 26, 1931.

FILLER METAL

These tests indicated the value of the specifications prepared by The Babcock & Wilcox Company and also showed the suitability of arc welding with coated electrodes and of riveted joints with steel of high tensile strength.

The form of electrodes for arc welding was discussed at the October, 1930, meeting of the Committee and the needs for specifications such as those contained in the 1928 report of the British Engine, Boiler and Electrical Insurance Company. These matters were referred to the Subcommittee on Welding and the American Welding Society Conference Committee. At the meeting of Jan. 23, 1931, these committees expressed the opinion that it was not practical at that time to specify the chemical composition which should be used in making welds of desirable quality. Attention was called to the work of the Committee on Welding Wire of the American Welding Society. The scope of its work would cover any action thought necessary. For these reasons the chemical composition for acceptable weld wire as given in the 1930 edition was eliminated from the Code. At this time, however, the B & W fatigue test indicated the superiority of coated electrodes.

The composition of base or parent metal and that of the filler metal had been stressed at a number of meetings by J. F. Lincoln of the Lincoln Electric Company. They had developed an equilibrium curve for welding steel after 18 months of investigation of the porosity of welds. The proper quantity of carbon, manganese, silicon, and aluminum was a factor contributing

to the amount of porosity. The composition of the base or parent metal fixed the composition of the electrodes or filling metal. The curves which had been presented at the meeting of April 23, 1931, were given to the Subcommittee on Welding at the meeting of May 28, 1931. On June 27, 1931, the Subcommittee reported that since the use of these curves would require many tests for their application they could not be included in the Code. The secretary was directed to thank Mr. Lincoln for his presentation and suggest that he should have it considered by the American Welding Society.

NONDESTRUCTIVE TESTS—RADIOGRAPHING OF WELDS

The testing of structures for soundness by x rays, mentioned by I. E. Moultrop at the Committee meeting of Jan. 14, 1925, and its continued use suggested to the Committee the application of x rays for nondestructive tests of welded joints. On May 24, 1929, C. W. Obert stated that in view of the fact that there was an apparent increasing demand for a nondestructive test he had wondered if the continuous steel rail testing device of Sperry might be applicable as well as the x-ray method. Information was given by some persons present at the meeting that several large builders of boilers and pressure vessels were investigating the Sperry continuous method of testing for faults in steel structures such as the A. O. Smith Corporation, the B. & W. Company, and the M. W. Kellogg Company, and hence it would be unnecessary for the Committee to seek this information at that time. In June, 1930, it was announced that a symposium on the specifications for fusion welding of drums of shells and power boilers had been held by the National Board of Boiler and Pressure Vessel Inspectors as well as another in April by the American Welding Society. Interested manufacturers had also written to the Committee on this subject. It was decided to refer all such information to the Conference Committee of the American Welding Society for use in the formulation of addenda.

At the meeting of the Executive Committee on Sept. 19, 1930, the recommendations of the Conference Committee of the American Welding Society regarding changes of welding rules were considered. These included one that in nondestructive tests joints should be radiographed by sufficiently powerful x-ray apparatus under a technique which would determine quantitatively the size of a defect. These rules were objected to by four boiler companies for various reasons: impractical commercially, inaccuracy, skill needed in application, exclusion of small manufacturers. The Power Boiler Group of the American Boiler Manufacturers Association thought it would be the best means of examination so far developed and should be used. Although W. D. Halsey of the Hartford Steam Boiler Inspection and Insurance Company was opposed to it originally, the work at the Watertown Arsenal had convinced him of its value. Others at the Committee meeting spoke so enthusiastically in favor of it that this much larger and more detailed section of the Code was substantially adopted for the 1931 edition of Sections of the Code.

The magnetic method of analysis of ferrous metal to determine imperfection in weld used by the Ferrous Magnetic Corporation of New York was brought to the attention of the Committee on March 27, 1931. The apparatus was demonstrated to Messrs. Obert and Partington in March, 1931. At the meeting of April 23, it was determined to defer its adoption for the present on account of its development at that time.

WELDING OF VESSEL PARTS

The following items were submitted to the Conference Committee of the American Welding Society for consideration: (1) The welding of angle irons and other structural supports; (2) the use of fusion welding on the calking edges of riveted joints; (3) the welding of tube ends of water-tube boilers and superheaters; (4) the effect on the metal of cutting boiler plate by electric-arc or oxygen cutting process; (5) the welding of holes and redrilling where they had been improperly located for riveted joints; and (6) the damage to Code plates if welded and the weld metal was removed.

These industrial questions were asked of the American Welding Society at different times from October, 1926, and the replies were reported by the chairman of the Subcommittee on Welding, James Partington, on Feb. 8, 1929. The actions on the six items are outlined in the following paragraphs:

(1) The AWS Conference Committee recommended that as the attachment of angles and structural parts to forged seamless steel drums by fusion welding depended on the type of the weld and because strains were set up in the plate by the bead or spot welds they did not believe that such should be used promiscuously but only when the plate did not exceed $^3/_4$ in. in thickness and the carbon did not exceed 0.25 per cent.

It was reported that members of the American Boiler Manufacturers Association had welded fittings to drums for a number of years under various conditions of thickness and had experienced no troubles. They were of the opinion that with thicker plates the effect of welding would be less injurious. They believed that the rule would be unnecessarily restrictive.

The Boiler Code Committee suggested that the weld be considered equivalent to a hole twice the maximum dimension of the weld in figuring the strength of welded or forged seamless drums and in no case the length of any weld should be over one inch for steel plate of over 0.30 per cent carbon and not over 3 in. when carbon does not exceed 0.30 per cent. They also made the latter diameter of the equivalent hole to be the maximum dimension of the weld plus $^1/_2$ in. Moreover the ligament efficiency between any two equivalent holes should not be less than the required efficiency of the drum. In no case should the diameter of the equivalent hole exceed that of a hole which did not require reinforcement. These were added to Par. P-186 on Dec. 6, 1929.

(2) The use of fusion welding on calking edges of riveted joints was not reported, but the Boiler Code Committee permitted it in Pars. P-257 and U-52 of the editions of 1931, adding a long paragraph (*b*) limiting it to plates of not more than 0.30 per cent carbon and to cases in which the shell was more than $^1/_8$ in. greater in thickness than that of a seamless shell for same diameter, shell, and pressure. Other requirements were given, and on unfired pressure vessels, rivet heads could be seal-welded. It may be noted that the Babcock and Wilcox Company had sealed the ends of butt straps on the inside of drums for a number of years.

(3) The welding of the ends of tubes of water-tube boilers or of superheaters could be practiced after expansion into the walls of drums in such a manner that they were accessible so that good welding could be done. The Boiler Code Committee did not adopt this recommendation completely. It prohibited the welding of tubes where they entered the steam or water drums but permitted the sealing of tube ends entering fittings or headers after expansion when the carbon did not exceed 0.30 per cent. This was added to Par. P-251 on Dec. 6, 1929.

(4) When the carbon of boiler plates did not exceed 0.35 per cent the heat effect of arc or oxygen cutting would not extend more than $^1/_4$ in. from the cut and the Committee believed that no harm would result. It believed that less harm would be done to the plate in such cutting than that resulting from cold shearing and should be permitted where shearing or punching was allowable. For plates over $^3/_4$ in. in thickness the limiting carbon content was fixed originally at 0.30 per cent.

(5) The welding of holes and redrilling for rivet holes should not be in the Code as it meant a change in rivet spacing and should be decided by the inspector.

(6) The effect of the removal of a piece of weld metal attached to a plate was such that it should not be in the Code and was a question to be decided by the inspector.

THERMIT WELDING

Thermit welding of tube ends was discussed at the meetings of March 20 and Oct. 24, 1930. With plain carbon steel tubes this method was equivalent to forge welding, as the Thermit was used only for heating the tube ends. When, however, the tubes were of alloy steel a full and thorough investigation should be made to determine the desirability and weldability of the tubes welded by this method. At a later meeting it was voted that when Thermit was to be used only for heating the surfaces to be joined and no extraneous metal was added, this method might be considered as forge welding.

STRESS RELIEVING

In the development of welding practice the fact that there were stresses set up in the metals at the weld became known, and so subsequent heating of the welded metal became necessary to eliminate these stresses. Stress relieving became the term to replace the term annealing used under forge welding in the 1927 edition of the Unfired Pressure Vessel Code. In the 1930 edition Par. U-87 was altered to require the temperature of at least 1100 F for stress relieving to be reached by a slow process and held at that temperature for at least a time equal to one hour for each inch of thickness followed by slow-cooling in air.

The limitation of size was deleted in the 1931 edition although treatment of distortions or deformations was provided as in the earlier edition. In the Rules for the Fusion Process of Welding, no provision was made for stress relieving in the 1927 edition. The 1930 edition had a new section, Par. U-72 (made possible by eliminating Par. U-72 of 1927), fixing the temperature at 1100 F except for vessels which might be distorted at that temperature but setting 1000 F for such structures. This section also provided for the heating of sections or bands of a vessel when necessary.

Par. U-76 on stress relieving of the 1931 edition called for this treatment on all vessels of Class 1 and for certain wall thicknesses of Class 2 vessels. The temperature remained at least 1100 F and up to 1200 F or higher if this could be done without distortion. Par. U-76, dealing with methods, applied to (*a*) the heating of the complete unit; (*b*) the heating of a complete section of the vessel containing the part or parts to be stressed relieved before attachment to the other sections of the vessel; and (*c*) the heating of the girth band for vessels made up of parts which have been stress relieved.

The Griscom Russell Company, through its representative, R. E. Kinkead, brought before the Boiler Code Committee (Oct. 24, 1930) a mechanical method of stress relieving and suggested changes to Par. U-23 on the extent of fusion welding. The Griscom-Russell system of stress relieving consisted of the use of their so-called G-weld in which welding was done by a step-back method with peening and cleaning between layers, thus relieving the stresses that might be set up. The report was studied by the AWS Conference Committee, and on Jan. 23, 1931, that committee reported that thermal stress relieving should be required for the highest grade of welded vessels and that the Griscom-Russell procedure had merit which could be recognized for certain classifications. The determination of such classifications for the Griscom-Russell or other method of welding for stress relieving would require tests such as the breathing test to give data for such a purpose before it could be added to the Code.

GASES FOR FORGE WELDING

Par. U-85 for Forge Welding stated, "the testing heating agent shall be suitably prepared water gas, or other heating mediums by which equivalent or superior results will be obtained." The use of natural gas as such other heating medium for forge welding was brought to the Committee on Oct. 25, 1929, by an inquiry (Case No. 636) from the Columbiana Boiler Company of Columbiana, Ohio, asking whether it would be permissible under Par. U-85 of the Code to use high-grade natural gas as the equivalent of water gas. The reply stated that the Committee had been informed that natural gas as burned by present methods was not equivalent to water gas as used for forge-welding pressure vessels. It was, therefore, of the opinion that natural gas should not be used as a heating agent for forge-welding of such vessels unless scientific data showed that the Committee had been misinformed.

This was annulled as a case at the meeting of Dec. 6, 1929, and was treated as an unofficial communication.

At the meeting of Jan. 24, 1930, H. LeRoy Whitney presented a report based on the experience of the M. W. Kellogg Company showing that flame temperature with water gas could be controlled better, giving the best deoxidizing flame. Natural gas and other hydrocarbons required three to four times as much air. Tests made in Pittsburgh by Boris S. Robinoff showed that natural gas could be used for hammer welding but it was not possible to secure uniformly perfect welds for commercial use. The proper air mixture was difficult to maintain in these burners with natural gas; the burners had to be larger and the spreading of the flame was more difficult. Two large companies in Pittsburgh had spent large sums to install water-gas equipment.

R. J. Barrow, secretary of the Columbiana Boiler Company, attended the meeting of May 23, 1930, and presented a comprehensive report of their practice which included a record of tests they had made for six months with natural-gas welds. He also exhibited samples, showing sections of forge welds with natural gas and water gas. They had used natural gas for hammer welding since 1925 with practically no failures from its use. As the report was extensive, Mr. Barrow explained its contents and filed the report with the secretary. An associate made an interesting statement on the origin of water gas as a heating agent for forge welding and on the development of the use of natural gas, explaining the scientific features desired by the Committee.

C. G. Segeler, industrial engineer of the American Gas Company, presented a report giving data from manufacturers using natural gas for forge welding for the files of the Committee. These reports were referred to the Subcommittee on Welding and the AWS Conference Committee.

On Oct. 24, 1930, James Partington, chairman of the Subcommittee on Welding, reported that the subject (heating gas) had been discussed at a meeting of the Tank Car Committee of the American Railway Association. At that meeting sufficient data to compare the use of natural gas and water gas were not available and he suggested that the Boiler Code Committee defer action. C. W. Obert, for the AWS Conference Committee, reported that evidence presented at the meeting of May was favorable to the use of natural gas of the composition in the Ohio districts as equivalent to water gas as a heating agent, as specified in Par. U-85. The Conference Committee recommended that Par. U-85 be broadened to admit other compositions of heating gases.

ALLOWABLE STRESSES OF HIGH TEMPERATURE

The temperatures of superheated steam in the boilers built during the early days of the Code were not high and as the critical temperature of saturated steam was just over 700 F

the known decrease in the strength of metals at high temperature was not considered in the early editions of the Code. However, the temperatures of superheated steam were increasing so that the temperature of much metal within the boiler setting was elevated because of heat transfer to points at which this decrease of strength could not be ignored. On Jan. 24, 1930, Dr. D. S. Jacobus submitted to the Committee his paper, "Working Stresses for Steel at High Temperatures," presented at the ASME Annual Meeting at New York, Dec. 2–6, 1929. In this he called attention to stress concentration at holes in drums and fatigue failures at such points, the passing of the elastic limit, and the permanent set resulting. With these he considered also the variation of stress across the thickness of heavy shells and the creep of the metal. Attention was given by him to the limit of working pressure set by the B. & W. Company, more than ten years before his paper, for a riveted oil-still drum of $1^3/_4$ in. plate. By quick time tests the stress was set at 7180 psi for 55,000-psi steel. They used 8000 psi for superheater design at 800 F and the stresses were set for lower temperatures. When the first curves on creep tests were published by H. J. French of the U. S. Bureau of Standards, Technical Paper No. 296, they were used in fixing the working pressure at two thirds of the creep strength, or one fifth the ultimate strength of a 55,000–65,000-psi ASME Code steel. Results were presented as Table 1 of the paper with temperatures from 650 F to 950 F in intervals of 50 F. The paper contained figures: Fig. 1, Tensile Strength of Carbon Steel at Temperatures from 100 to 1000 F from six different investigators; Fig. 2, Yield Points for Carbon Steel from 10 Investigators; Fig. 3, Proportional Limits from Six Investigations; and Fig. 4, The Creep and Proportional Limit Values for Carbon Steels, by H. J. French. These were followed by Fig. 5 and Table 2 from the text, Creep of Steel at High Temperatures, by Prof. F. H. Norton, showing creeps in per cent per hour × 100,000 vs. stress. Then in Figs. 6 and 7 the Creep Values of Stress for 1 per cent in 100,000 hours at different temperatures were given from tests reported in 12 papers mentioned in the bibliography.

After this was presented the Committee voted that the data from the paper be prepared in form for addenda to the Codes and that Dr. D. S. Jacobus and H. LeRoy Whitney arrange them for publication in MECHANICAL ENGINEERING.

DISHED HEADS

The Special Committee on Dished Heads, D. S. Jacobus, E. R. Fish, and S. F. Jeter, had been appointed after the discussion of the four papers by Miller, Rockefeller, Greene, and Kinzel, previously mentioned. Dr. D. S. Jacobus, chairman, reported on Jan. 13, 1928, that the desired revisions for this part of the Code were not quite complete and suggested that they be submitted to the Executive Committee so as to avoid delay in their publication in MECHANICAL ENGINEERING. At this meeting the results of hydrostatic tests of two soaking drums, 6 ft in diameter, with dished heads, were reported by C. H. Haupt, chief engineer of the Standard Oil Company of New Jersey, and referred to the Special Committee.

On April 13, 1928, the revisions of Pars. P-195, P-197, and P-198 on dished heads were reported with a change of the factors and constant of the formula in Par. P-195 for the thickness of the dished heads, with the stipulation that when the head was formed as a segment of a sphere, the radius L of the formula was to be measured on the concave side of the head. The increase of thickness of heads due to the presence of a manhole was made 15 per cent of the thickness by the formula but never less than $^1/_8$ in. Where the head had a flanged opening supported by a flue, no increase in thickness was required. Then the maximum radius of the head was made the diameter of the shell. When L was less than 80 per cent of the diameter of the shell the thickness to allow for the presence of a manhole must be at least that found by the formula making L equal to 80 per cent of the shell diameter. The revision provided for the use of a semielliptical form of head in which the minor axis was at least one half the major axis with a thickness at least equal to that of the shell. When a manhole was present the thickness was that for a head of any form having a manhole. When the dished head was attached to the outside of the shell, the outer diameter of the shell fixed the value of L, while the inner diameter of the shell fixed L when the head was attached on the inside. Par. P-197 was revised to make the corner radius of an unstayed dished head to be not less than three times the thickness of the head and also not less than 6 per cent of the diameter of the shell. Par. P-198 was revised to make the depth of the flange of a flanged manhole, when measured from the outside of the head at the minor axis of the hole, to be not less than three times the thickness of the head for plates up to $1^1/_2$ in. For plates over $1^1/_2$ in. the depth was to be equal to the thickness of the plate plus three inches. The revisions also permitted the use of riveted manhole frames or other attachments on a manhole opening. The rules for the elliptical head with a manhole were corrected on Sept. 13, 1927, so that the thickness should be the same as that for an ordinary dished head with a radius equal to 0.8 of the diameter of the shell plus the added thickness for the manhole.

As these changes permitted the use of elliptical heads, the use of such was greatly increased, and A. E. Allison, chief engineer of the Worth Steel Company, appeared before the Committee on Feb. 8, 1929, to explain their practice in meeting this demand. He stated that it was impossible in manufacture to meet the requirements unless some small departure from a true ellipse was permitted, thus using a form nearly ellipsoidal. The Committee thereupon appointed a special committee of representatives of the Bethlehem Steel Corporation, the Lukens Steel Company, and the Worth Company to submit recommendations.

Charles H. Brown of the Lukens Steel Company was named chairman. This committee held three meetings and the chairman reported on March 22, 1930. This report pointed out that the principal question was commercial, dealing with the expense of manufacture. It was agreed that if any tolerance was permitted it must be defined. The committee submitted a slight revision of that part of Par. P-195 dealing with semielliptical forms of dished heads and added a paragraph making the maximum clearance between the approximate shape and the true shape to be not greater than 1.25 per cent of the inside head diameter. The special committee recommended that elliptical heads be designed on standard inside radii starting with 24 in. and progressing by 6-in. increments. This was again reported by the Executive Committee and with slight changes the report on Par. P-195 was approved on April 19, 1929. At the suggestion of V. M. Frost the special committee prepared Par. P-195 with a figure describing the method of checking the tolerance. This was adopted on May 24, 1929.

A German set of rules for the wall thickness of dished heads, with pressures on the convex side, was submitted to a special committee of H. E. Rockefeller, R. K. Hopkins, and W. A. Jones. These were the rules of the German Union of Large Boiler Owners.

On the inquiry of the Bigelow Company of New Haven, Conn. (May, 1931), regarding the design of a special dished head of an electric steam generator, a special committee was appointed with D. B. Wesstrom as chairman for a study of this inquiry. He reported on June 17 that the head came under various sections of the Power Boiler Section of the Code and hence the Committee recommended a hydrostatic test of Par. P-247, as it had earlier for many other structures of this company.

OPENINGS AND CONNECTIONS

The subjects of openings and connections were brought together in the editions of this period, whether the openings were unreinforced, or with threaded, riveted, fusion-welded,or bolted nozzles.

The question of reinforcing plates, given in Par. P-193, naturally suggested the limiting size of an unreinforced opening, and on March 1, 1929, Dr. D. S. Jacobus wrote to the Executive Committee that the revisions of the Par. P-268 and U-59 on threaded openings showed the necessity of embodying in the Code a rule defining the maximum diameter of unreinforced openings. This, he pointed out, was not a new question, as a letter from Perry Cassiday to Messrs. Jeter and Partington on Sept. 17, 1925, enclosed a letter of Sept. 16, 1925, from W. A. Jones of the B & W Company which gave a theory for the determination of the maximum diameter of an unreinforced opening and stated that from this theory he would add to Par. P-193 a statement regarding such limits. He also stated that the largest diameter of an unreinforced circular opening that might be used in a drum should be determined by one of three formulas of the letter. The formulas were followed by tables giving the maximum diameter of openings for four different radii of drums, each with efficiencies vertically and thicknesses horizontally. An enclosed letter from Mr. Jones gave his development of the formulas.

At the meeting of April 19, 1929, these formulas and curves were discussed, and H. LeRoy Whitney called on D. B. Wesstrom to give the results of the tests made to check the formulas, as he had examined the Jones theory. These showed that failure was at the sides of the hole where stress was much above the average longitudinal stress and that doubling the thickness would double the pressure at failure. He believed that the formula would apply to thicknesses up to $1^1/_4$ in. but beyond that it should not be used.

Further study of this subject was referred to Messrs. Jacobus and Whitney for a report.

On May 29, 1929, Messrs. Jacobus and Whitney made the report on changes in the earlier revision of Par. P-193, and formulated a paragraph as follows: "The largest diameter of an unreinforced circular opening in the shell of a drum shall not exceed 8 in. in any case, nor shall it exceed the values given by the following equations when such values are less than 8 in." Then followed three new formulas which differed from the Jones formulas. They also gave the maximum diameter for different pressures from curves of different efficiencies of drums with a thickness of 1 in. The size for any other thickness would be determined by multiplying the chart value by the thickness of the plate to be used.

The thread-opening requirements which had appeared in Pars. P-268 and U-59 and those for nozzles and threaded connections of Pars. U-76 and U-77 with their figures were brought together as Par. P-268 in Section 1 and Par. U-59 in Section VIII with the necessary figures by addenda during 1928, 1929, and 1930. The necessary formulas for the maximum diameter of unreinforced openings with nozzles forge-welded to the shell and for one which required reinforcement, with illustrative figures, were given in Par. P-268, while the formulas for the largest unreinforced opening which were in Par. P-193 were also in Par. U-76. Each of these sections contained separate divisions on threaded openings; nozzle fittings, flared connections; nozzle fittings, expanded connections; stress relief; nozzle fittings, riveted connections; nozzle fittings, forge-welded; and nozzle fittings, stud-bolted connections. In Par. U-76 there was one additional section on nozzle fittings, Fusion Connected.

On May 28, 1931, the Committee appointed a special committee to consider these rules for reinforced openings consisting of Messrs. R. B. Wesstrom, chairman, Paul Diserens, A. B. Kinzel, W. H. Rowand, and R. E. Cecil. This committee was especially asked to report on the conflict between Pars. U-59 and U-77 as well as the bearing of these paragraphs on Case Nos. 686 and 689. Mr. Wesstrom reported on these and framed the replies calling attention to changes which should be made in the new rules to be issued. The report of the committee on Sept. 18, 1931, stated that it had held meetings and that the problems of these changes were so difficult that careful study was needed. They were trying to find a formula to replace the Jones formula for unreinforced openings and also the maximum permissible diameter of holes in boiler and superheater headers. They needed more time and they expressed the desire for comments by the Boiler Code Committee.

MATERIALS

The chairman of the Subcommittee on Material Specifications, Perry Cassidy, reported changes in the specifications at many of the meetings of the Boiler Code Committee during these years. These were for the purpose of making the specifications identical or in substantial agreement with those of ASTM, or to make changes in those for which none was given by ASTM. The ASME Conference Committee met with similar conference committees of the ASTM and AASM, the three forming the Subcommittee on Materials Specifications.

On March 22, 1929, Mr. Cassidy reported that the Subcommittee had held several meetings and recommended that the specifications be made more uniform in the matter and arrangement with those of the ASTM by starting each specification with paragraph 1 and following consecutively as in those of ASTM, and that Pars. S-1 to S-4 of the 1927 Code (on inspection, rejection, ladle analysis, check analysis, and physical tests) be deleted as they would appear in the different specifications as in those of ASTM. The Subcommittee recommended that Section II should start with General Rules giving the speed of testing machines. It also recommended that some reference be made to indicate that a specification was identical with, in substantial agreement with, or based on that ASTM specification with its ASTM designating number. By 1931, nineteen specifications were identical with ASTM specifications, one in substantial agreement, and two based on such specifications, while three were not marked (S-3, Steel Plates for Brazing, S-4 Seamless Steel Forging, and S-6, Steel Bars for Stay Bolts). This report also included two pages of changes to be made in Section II of the Code.

During this four-year period the ASTM specifications for the Arbitration Test Bar and Tension Test for Cast Iron, ASTM-A124–29, was accepted on Jan. 24, 1930, for the Code and became S14. At this same meeting a proposed specification of Nickel Steel Boiler Plates was accepted as suitable for a special boiler in accordance with Par. P-1 of the Code, permitting this practice of approving new materials. The ASTM Specification for Open Hearth Iron Plates of Flange Quality was adopted on Sept. 19, 1930. Later the ASTM included electric-furnace steel with open-hearth steel in many of its steel specifications in paragraphs 2 on Process.

Electric-furnace steel was ruled to be the equivalent of open-hearth steel when all other Code requirements were met (Feb. 29, 1930), and in March the subcommittee was requested to prepare specifications for high-carbon seamless steel tubes.

MISCELLANEOUS

SPECIAL BOILERS

The two Benson boilers and other boilers for high pressure as well as the GE mercury boiler were brought before the

Committee for their examination and in each case, on account of the place of use, the reason of the use, and the standing and responsibilities of the owners and the builders of the boiler, these were approved as special installations under the parts of the Code giving the authority for such action.

FORM OF STAMP

The form of the stamp to be used on vessels built and inspected under different sections of the Code was altered on Oct. 26, 1928, so as to replace the clover leaf with the letter S for all vessels, regardless of the section governing their inspection, by the clover leaf with S, L, H, M, or U in the center to designate the section of the Code under which it was inspected.

VARIOUS COMMITTEE ACTIONS

The support of the Nicholson Thermic Siphon was brought to the attention of the Committee on May 24, 1929, by F. A. Page, chief of the Boiler Department, Industrial Accident Commission of California. The attachment of this by welding in accordance with Par. P-186 brought loads on other stays and the method of staying was questioned. On June 21, 1929, A. G. Pack, chief boiler inspector of the Interstate Commerce Commission, advised the Committee that adequate stays should support the load from the siphon. The request was again considered at the meeting in September and replies were sent on Oct. 10, 1929, answering the four parts of the inquiry.

On Oct. 25, 1929, all obsolete cases were annulled and these annulments were published.

The announcement that the Code had been adopted by the City of Mexico as its standard was made on March 22, 1931. This was the first adoption of the Code by a foreign city.

The subject of cold-flanging mentioned in the last chapter was carried on into October and in December of 1928 when a new report was made by an enlarged special committee in which some of the requirements were altered. C. L. Huston asked to be relieved of the chairmanship of an enlarged committee. As the problem before the committee in 1926, however, was no longer before the Boiler Code Committee in 1931, further consideration of the Rules for Cold Flanging to be incorporated in the Code was discontinued on May 28, 1931.

EFFECTIVE DATE OF ADDENDA

The date at which approved addenda would become part of the Code and made mandatory was discussed on June 15, 1928. It was again recommended that on January 1 the addenda published and issued on the sheets up to the previous July 1 should be legally considered parts of the Code.

TESTS AND MISUSE OF STAMP

Tests to determine allowable working pressure permitted under Par. P-247 for fixing the allowable working pressure on structures were carried out in 1928, 1930, and 1931—one in 1928, four in 1930, and two in 1931.

There were a few minor improper uses of the Code symbol during these years.

INTERNATIONAL CO-OPERATION

In 1930 joint co-operation of the Boiler Code Committee was requested in the formation of an International Standards Association. John Gaillard of the American Standards Association appeared before the Committee and explained that at a meeting of a proposed association at Paris in May, such subjects as the purchase specifications for boiler plates and the hydrostatic acceptance tests of boilers would be discussed and would be of interest. The Committee could not recommend a delegate as it did not know what was contemplated by this international organization.

A paper by F. R. Low and D. S. Jacobus on the work of the Boiler Code Committee for presentation at the World Power Conference of 1929 in Japan was authorized on Sept. 15, 1928. The four-page paper entitled "Formulation of Rules for the Construction of Steam Boilers and Other Pressure Vessels and Their Care in Service," gave the origin and extent of the Code.

Permission, subject to ASME Council approval, to translate the Suggested Rules for the Care of Power Boilers into the Gujarati language was given on April 13, 1928, to S. A. Tasker, inspector of steam boilers and smoke nuisances of the Bombay Presidency for the use and benefit of thousands of boiler attendants in India.

AMERICAN MARINE STANDARDS COMMITTEE

V. M. Frost, chairman of the Special Committee appointed to co-operate with the American Marine Standards Committee, reported on Jan. 13, 1928, that his committee had given considerable study to the proposed Code covering the design and construction of marine boilers submitted by A. V. Bouillon, secretary of the American Marine Standards Committee, as reported in the last chapter. The special committee had formulated a letter to Mr. Bouillon making nine suggested changes to the proposed code using expressions in the ASME Codes. The Boiler Code Committee approved the letter for transmittal and directed that a copy be sent to the Hon. D. N. Hoover, supervising inspector general of the Steamboat Inspection Service. The report made by Mr. Frost on the steel specifications of the proposed Code was referred to the Subcommittee on Material Specifications. On Feb. 9, 1928, three other revisions were sent to Mr. Bouillon.

At this meeting the Special Committee requested appointment of an additional member acquainted with marine practice and H. A. Aldrich was named.

The American Marine Standards Committee on Rules met at the New York Customs House on Feb. 9, 1928, with Messrs. Jacobus and Obert representing the Special Committee. The group approved the following: The heading "Cylindrical Shells of Scotch Marine Boiler" changed to "Cylindrical Shells of Internally Fired Boilers"; the factor of safety of four with proper addendum; a construction factor of safety to allow ample margin for deterioration; and the tensile strength in the allowable pressure formula for boiler shells made the minimum of the range. The appointment of a special subcommittee of five to consider the proper construction and factor of safety for water-tube boilers as well as other suggestions not yet considered was also approved. This special subcommittee was composed of: Henry C. E. Meyer, chief engineer, Gibbs Bros.; D. S. Jacobus, advisory engineer, B & W Company; David Arnott, chief surveyor, American Bureau of Shipping; W. W. Smith, chief engineer, Federal Ship & Dry Dock Company; and J. W. Wilson, Steamboat Inspection Service.

This special subcommittee met on Feb. 17, 1928, and it adopted a factor of safety of four in view of the foreign marine codes and because of the effect of a higher factor when foreign-built boilers came under American jurisdiction. It agreed that the use of an operation factor of safety was better cared for by the addition of $^1/_{16}$ in. to the thickness of the plate. It then sent a communication of these results to the Boiler Code Committee to ask for its sanction.

The foregoing was reported to the Boiler Code Committee on Feb. 24, 1928, and discussed by the members, and J. W. Wilson of the Steamboat Inspection Service was asked for his opinion. After discussion the Committee reaffirmed its endorsement of the suggestion made by its own special committee for changes in the proposed Code, including the use of the ASME Code Table for Tubes of Water-Tube Boilers as well as the use of $4^1/_2$ as the factor of safety.

A hearing on these questions, at the Boiler Code Committee on Oct. 26, 1928, resulted from the failure of the special subcommittee to reach an agreement at two meetings following the one in February. David Arnott pointed out that the proposed code was being prepared with consideration for the present rules and in an endeavor to bring agreement between the American Bureau of Shipping rules and those of the Steamboat Inspection Service. The American Bureau of Shipping was one of a number of classification services, such as the British Lloyd's Register and the French Bureau Veritas. In the early years, 1886, the British Board of Trade called for a factor of safety of five, subject to an increase for poor workmanship. Lloyd's at that time had a factor varying with thickness of plate from $5\frac{1}{2}$ to 4.84. In 1893 a new classification society, The British Cooperatives, reduced the factor to 4 with a $\frac{1}{16}$-in. addition to thickness. Lloyd's about this time reduced its value to 4 with a $\frac{1}{8}$-in. addition. The Board of Trade retained its factor but later reduced it to $4\frac{1}{2}$. In 1917 the British engineers combined their efforts to have a common standard. A. E. Seaton, whose work is known to many engineers of the late nineteenth century, was chairman of a committee made up of two engineering professors, three classification engineers, eight marine engineers, eight superintending engineers, and two steel manufacturers to arrange rules for marine service. There were also representatives of Bureau Veritas. They agreed that the superior quality of materials and workmanship justified the reduction of the factor to 4. On the publication of the results of the work of this committee and the new rules of the inspection services, the American rules came under examination and those of the Bureau of Shipping were changed in 1917. They were found to be in substantial agreement with those at the present and it was not difficult for the subcommittee of the American Marine Standards Committee to bring them into agreement, except for the heavier boiler tubes required by European practice and the proposed formula for dished heads. For the latter, the subcommittee had adopted the ASME Code rules. Mr. Arnott spoke of all of the Codes at that time and believed that it would be impracticable to adopt 5 as the factor of safety for Scotch-marine boilers when 4 was used in marine practice. He felt that unless the practice of that day could be proved wrong he would prefer the existing standards, which would be international. Regarding the heavier tubes, these were more serviceable for marine use and those for water-tube boilers were about only one gage heavier. Also the addendum of $\frac{1}{16}$ in. was called for in the foreign rules.

Dr. Jacobus spoke on the use of the proper factor of safety for Scotch-marine boilers and that for water-tube boilers, which should be higher. He pointed out that for 1-in. plates the Board of Trade rules gave a factor of safety for shell plates of 4.11, the American Bureau of Shipping, 4.26, proposed ASME, 4 5, while for 2-in. plates the respective values were 4.00, 4.12, 4.5. For tubes, he pointed out that for lower pressures there were small differences but at high pressures of 1500 psi these were considerable. The thicknesses at different pressures for Code tubes had been tested by practice and heavier tubes should not be required. The use of a minimum factor of safety of 4 had been written into the Locomotive Boiler Section of the Code for service conditions.

J. W. Wilson of the Steamboat Inspection Service stated that his objections were those made by Mr. Arnott. He also stated that his Service had to protect the public and he recommended that a minimum factor of safety be given with an operating factor such as the $\frac{1}{16}$-in. addendum. He stated that the rules were made for Scotch-marine boilers and his Service had to inspect at least 20 types of boilers which could not be constructed from the proposed rules without additional formulas.

Wm. H. Boehm stated that a minimum factor of safety was necessary when an insurance company was asked to write a policy and he favored the factor of 4. Construction factors could not be used in setting the pressure for an old boiler.

It was then suggested that agreement might be reached at the meeting. Finally, a wording, "The factor of safety used in determining the maximum allowable working pressure on conditions actually obtained in service shall not be less than 4.0," was approved. The ASME table for seamless tubes was approved by those present, but acceptance by the other members of the subcommittee of the American Marine Standards committee was not assured.

A copy of a letter from V. M. Frost to A. V. Bouillon appeared as Appendix IV to the minutes of the meeting of Dec. 13, 1928, stating that agreement had been reached respecting the factors of safety and thickness of tubes but that as the proposed code stood there was not an agreement on (1) specifications for materials, (2) rules for water-tube boilers, (3) scope of code, and (4) number of other changes which could be made to advantage.

V. M. Frost reported on April 19, 1929, that the foreword to the proposed AMSC Code contained statements which required change and a letter was sent by the Committee calling attention to them. In minutes of May 24, 1929, the reply of Mr. Bouillon was noted together with the rewording of the foreword which was approved. The special committee then wrote to the Hon. D. N. Hoover for preliminary copies of the proposed rules of the Steamboat Inspection Service so that it might have them to report to the Boiler Code Committee at its June meeting. Although not stated in the minutes of the Boiler Code Committee at this time there were two proposed sets of rules, one by the American Marine Standards Committee, using the rules of the American Bureau of Shipping, and one by the Steamboat Inspection Service.

The copy of the rules was obtained from John G. Dudley, acting supervising inspector general, and copies were made for each Committee member by the Boiler Code Committee. At the meeting of June 21, 1929, J. W. Wilson, Steamboat Inspection Service, advised the Committee that these tentative rules of the Service had received the approval of the Board of Supervising Inspectors and were released for comments and suggestions. They were based on ASME Code in so far as the Code applied to marine boilers and other marine codes had been used for parts as they applied particularly to marine construction such as Scotch-marine boilers. These copies, as they became available, were to be sent all over the country to shipping interests, boiler manufacturers, technical organizations, and those interested in marine boiler construction. The Service would appreciate comments of the Boiler Code Committee as soon as possible so that they could be studied in preparation of the draft.

The Committee sent to the Service 100 mimeographed copies of the Code which it had prepared for its members. It passed a resolution commending the Steamboat Inspection Service for preparing a complete set of rules for the construction of marine boilers and referred the rules to its Subcommittee on Marine Boiler Rules and empowered the Executive Committee to act for the Boiler Code Committee in submitting any criticisms or suggestions to the Steamboat Inspection Service.

At this meeting the former name of the special committee to confer with the American Marine Standards Committee was changed to the Subcommittee on Marine Boiler Rules.

Progress was reported on the study of the proposed rules on Sept. 20, 1929, and J. W. Wilson was asked if certain revised rules of the Boiler Code, such as those for dished heads, should be reported for revision. To this he assented, and he said that he would be pleased to co-operate with the Committee in deciding what should be incorporated and to make the typo-

graphical changes which were reported. Mr. Wilson stated that their Board would be glad to make changes in the material specifications where these had been changed in the ASME Code.

V. M. Frost, chairman of Subcommittee on Marine Boiler Rules, reported at the meeting of Oct. 25, 1929, that the Subcommittee had made a thorough study of the proposed rules and advised that they had six items to offer for corrections: Maximum size of openings without reinforcement, factor of safety (4.5), reinforcing plates, formula for dished heads, apparent error in Pars. P-81 and P-12 regarding connections, and limitations in the table for flanges. These suggestions were ordered sent to the Steamboat Inspection Service. J. W. Wilson stated that he believed these would be adopted. He also stated that Lloyd's Register had written the Service that the use of the proposed rules for calculating the working pressure for vessels built and owned in the United States would be accepted.

NEW COMMITTEE FOR MARINE BOILER RULES

Rear-Admiral H. I. Cone had called on C. E. Davies, acting-secretary ASME, to ascertain to what extent the Society had participated in the formulation of Marine Boiler Rules. Mr. Davies had consulted D. S. Jacobus and on Dec. 5, 1929, Dr. Jacobus presented to the Committee a letter which he had prepared giving this information. This five-page letter covered the story of the appointment and the participation of the special committee and the treatment it had experienced, the things desired, and the reasons for them and the final outcome. It was a full and fair statement and when read at the meeting at which J. W. Wilson of the Service was present, he was asked if he thought the letter showed any unjustified positions. To this he replied that its participation had appeared to him dignified and courteous and that in so far as the U. S. Steamboat Inspection Service was concerned there could be no question that Society co-operation had been invited and desired. He also stated that recent reports indicated that the Boiler Code Committee had been misrepresented in so far as its co-operation and assistance in this work were concerned.

The outcome of certain protests made to the Secretary of Commerce was his request that those interested in the Codes settle their differences and report back to him. Mr. Wilson said that he had understood that there had been a proposition to appoint a new committee to draw up a new Code, to scrap the present proposed rules of the Steamboat Inspection Service, and to have no Boiler Code Committee representative on the new committee. He therefore urged the committee to request representation should a new committee be appointed. The Boiler Code Committee then appointed D. S. Jacobus, V. M. Frost, C. G. Gorton, and C. W. Obert to interview the Secretary of Commerce, the Hon. R. P. Lamont, with a view to placing the facts before him.

Dr. D. S. Jacobus reported on Jan. 24, 1930, that in accordance with the action at the December meeting, Messrs. Frost, Gorton, Obert, and he called on the Hon. R. P. Lamont on Dec. 16, 1920, and were graciously received by him and told that another committee representing the American Society of Naval Architects and Marine Engineers had complained of the conflict between the two proposed marine boiler codes. Mr. Lamont stated that after listening to the SNAME statements he had requested that a new committee be formed to endeavor to iron out the differences which existed between the American Marine Standards Committee and the Steamboat Inspection Service.

Secretary Lamont expressed the hope that ASME would do what it could to assist in this "straightening" as he had been informed that the Society had been requested to appoint a representative on the special committee to investigate this matter.

Dr. Jacobus reported later that a special committee had been appointed consisting of a representative from each of the following organizations: American Marine Standards Committee, American Steamship Owners Association, National Council of American Ship Builders, Society of Naval Architects and Marine Engineers, The American Society of Mechanical Engineers, and the U. S. Steamboat Inspection Service. Several meetings of this special committee had been held since its appointment to review what had been done by the American Marine Standards Committee and by the Steamboat Inspection Service in the preparation of a Code for the Design and Construction of Marine Boilers, so as to prepare a combined set of rules to be submitted to all parties for approval. This committee established with the approval of Dickerson N. Hoover, assistant director of Bureau of Navigation and Steamboat Inspection, consisted of W. M. McFarland, chairman (Society of Naval Architects and Marine Engineers), H. L. Seward (SNAME and American Bureau of Shipping), Chas. F. Bailey (National Council of American Shipbuilders), John L. Crone (Bureau of Navigation and Steamboat Inspection), D. S. Jacobus (The American Society of Mechanical Engineers), B. E. Meurk (American Society of Steamship Owners Association), and H. C. E. Meyer (American Standards Committee).

There was a subcommittee consisting of J. Bergvall (American Bureau of Shipping), A. V. Bouillon (American Marine Standards Committee), and J. W. Wilson (Bureau of Navigation and Steamboat Inspection).

Since the matter of the preparation of this Code was in the hands of the committee of six there was no further action brought before the Subcommittee on Marine Boiler Rules during 1931.

AMERICAN PETROLEUM INSTITUTE API-ASME CODE

A conference was held May 19, 1931, at ASME Headquarters between W. R. Boyd, vice-president of the American Petroleum Institute, and Dr. R. P. Anderson, their technologist, and Roy V. Wright, President ASME, Calvin W. Rice, Secretary ASME, T. R. Weymouth, member of the ASME Council, and D. S. Jacobus, past-president ASME, chairman, Executive Committee of the Boiler Code Committee, for the purpose of discussing a proposal that the American Standards Association organize a sectional committee to prepare a Code for Unfired Pressure Vessels for Flammable Liquids and Gases.

Mr. Boyd reviewed the pressure-vessel situation and it appeared to him that the petroleum industry should have the final say for pressure vessels used in its refineries. The Institute desired to co-operate with ASME on a basis whereby it would have the same authority in producing a final Code as the ASME. He believed that this could be done working under the American Standards Association.

In the general discussion which followed, Secretary Rice pointed out the advantages of working in co-operation with Boiler Code Committee, founded before the American Standards Association. Moreover the establishment of a Code under the Association would be duplicating the Unfired Vessel Code and lead to confusion.

President Wright endorsed the statements of Secretary Rice regarding the willingness of ASME to co-operate with the Institute and requested those present to be frank in expressing their views.

Dr. Jacobus pointed out that in the preparation of the first edition of the Unfired Vessel Code public hearings were held on the several preliminary printings giving the proposed forms for discussion to interested parties. He quoted a letter of Jan. 12, 1925, from C. A. Young which asked exclusion from the code of vessels to be used in references. This request had been

granted. The wording of this exemption had been written by R. L. Welch of API. This exemption had been retained in the later editions. He also stated that the Code Committee wished the co-operation of the Institute and called attention to that with the Compressed Gas Manufacturers Association.

Mr. Weymouth suggested that the API Committee on Unfired Pressure Vessels co-operate with the Boiler Code Committee in the preparation of a Code which would be acceptable to both. On asking if this could be done, Messrs. Wright, Rice, and Jacobus said that it surely could be done and there would be mutual and friendly co-operation. Dr. Anderson pointed out that the final approval was by the Council of ASME and the Institute would not have much authority in this action.

Dr. Jacobus then proposed the appointment of a representative of the petroleum industry on the Boiler Code Committee and on the Subcommittee on Unfired Pressure Vessels. This was not quite enough, in the opinion of Dr. Anderson, as the ASME Council was still supreme.

From this discussion it was evident that it would not be advisable to have this work under the limitations of the American Standards Association.

It was finally suggested that a special committee of members appointed from the American Petroleum Institute and from the ASME be formed to prepare a Code particularly adapted to the petroleum industry. Secretary Rice suggested that Mr. Boyd and Dr. Anderson consider this and send a proposal to the Society embodying their desires.

After some discussion on limitations, Secretary Rice expressed his appreciation of the courtesy of the American Petroleum Institute in bringing this matter to the attention of the Society before approaching the American Standards Association and that he and President Wright wished to do their best in co-operating with the API in its work.

CHANGES IN PERSONNEL

The grade of Honorary Member of the Boiler Code Committee was established by resolution passed on Feb. 8, 1929, and approved by the ASME Council on March 29, 1929. Election to this grade was awarded to those who had retired after active service for a number of years. The first honorary members elected (May 24, 1929) were Thomas E. Durban, W. F. Kiesel, Jr., and H. H. Vaughan, and on Feb. 20, 1930, C. L. Huston was so honored.

The death on Feb. 3, 1929, of S. W. Miller, one of the most active and effective members of the Subcommittees on Welding and on Unfired Pressure Vessels, was a great loss to the Boiler Code Committee as was that on Nov. 17, 1929, of the former chairman, John A. Stevens, who had directed the work of the Boiler Code Committee from its organization in 1911 to 1927. S. F. Jeter, who died on Dec. 31, 1929, was another of the active members of the Boiler Code Committee who constructively contributed to its effectiveness.

The Main Boiler Code Committee lost from its membership John A. Stevens (Nov. 17, 1929), S. F. Jeter (Dec. 31, 1929), Thomas E. Durban (Feb. 8, 1929), C. L. Houston (Jan. 24, 1931), and LeRoy Mikels (Jan. 23, 1931). Appointments to the Committee were: LeRoy Mikels (Sept. 26, 1929) and H. B. Oatley (April 25, 1930).

H. E. Aldrich was added to the special committee to confer with the American Marine Standards Committee, Jan. 13, 1928.

On May 24, 1929, the resignations of E. G. Bailey, W. G. Disman, J. W. Hayes, and J. S. Shumaker from the Subcommittee on Rules for Care led to the appointment of Howard J. Kerr (B. & W. Company), and John A. Hunter (American Sheet & Tin Plate Company). F. G. Straub and Shepherd T. Powell had been appointed on Dec. 8, 1928, on the death of M. F. Newman.

F. B. Howell became chairman of the Subcommittee on Low Pressure Heating Boiler Code on the death of S. F. Jeter. R. W. Bischfield resigned from the subcommittee on April 13, 1928, and was succeeded by W. A. Nevin. O. T. Nelson resigned from the subcommittee on May 23, 1930, and was succeeded by the appointment of J. W. Turner, chief engineer of the Pacific Boiler Corporation. On Jan. 23, 1931, W. E. Stark (Gas Heating Boilers), F. W. Herendeen (Institute of Boiler and Radiator Manufacturers), and Raymond Newcomb (Fitzgibbons Boiler Company) were appointed to the subcommittee.

On May 23, 1930, E. R. Fish and C. O. Meyers were appointed to the Subcommittee on Miniature Boilers for the places of W. P. Eales and S. F. Jeter, deceased.

F. G. Cox was appointed to the Subcommittee on Inspection, and on the resignation of Charles S. Blake, John A. Collins was appointed a member and chairman of the subcommittee on Dec. 5, 1930.

R. E. Cecil and S. M. Miller were appointed to the Subcommittee on Unfired Pressure Vessels on May 11, 1928, and on Oct. 23, 1931, Dr. C. A. Adams, D. B. Wesstrom, A. W. Lemont, Jr., and either H. S. Smith or H. E. Rockefeller were appointed to this subcommittee to which Paul Diserens had been appointed on Jan. 23, 1931.

A. S. Kinsey withdrew from the Subcommittee on Welding on Jan. 23, 1931. On the return of Frank H. Clark from China, he again joined the Subcommittee on Locomotive Boilers on Nov. 11, 1928.

On Oct. 23, 1931, the Boiler Code Committee decided that in the combined edition of the Code, the name of the professional activity with which each member was associated would be omitted in listing members.

1930 EDITIONS OF ASME BOILER CODE

SECTION I—POWER BOILERS

The addenda from the revision sessions of 1928 to 1930, which had been published in MECHANICAL ENGINEERING, resulted in the edition of 1930 printed in December of that year. The section on Welded Joints, Par. P-186, was enlarged to include forged drums. The principal changes were made in Par. P-193 referring to reinforcing plates, in Par. P-195 for dished heads, and in Par. P-268 on nozzle openings. In the first of these, formulas were given for the largest diameter of unreinforced circular openings, and a diagram was given to determine the efficiency of diagonal ligaments in order to obtain the equivalent longitudinal efficiency.

The formula for the thickness of dished heads of Par. P-195 was changed, and more details were given to cover various forms. Par. P-268 dealing with nozzle openings was extended from slightly more than one half page to five pages to include threaded openings and different types of nozzle fittings, giving formulas for the diameter of the nozzle and a figure for six forms of acceptable nozzles.

Par. P-194 was extended to give the requirements to be met when the diameter of a dome was greater than six tenths of the diameter of the shell or barrel to which it was attached. Par. P-249 on tube holes and ends was enlarged to include counter-boring, and a figure was added to illustrate the methods of inserting tubes in drums with thick walls.

In this edition the specifications of Section II were given designating titles from S1 to S24 and the various principal paragraphs in each were numbered consecutively. This group contained three new specifications: S6 for Forged or Rolled-Steel Pipe Flanges for High-Temperature Service, S9 for Alloy-Steel Bolting Material for High-Temperature, and S14 for Arbitration Test Bar and Tension Test Specimens for Cast Iron. All of the specifications had been brought into closer agreement with those of the ASTM Specifications.

In the Appendix, new tables were given for all steel flanged fittings using the recent Standards of the American Standards Association. These now referred to flange dimensions only and a new figure on type of flanges and flange faces replaced the former plate of flanged fittings giving the dimensions between ends and faces and side faces.

The tables covered pressures up to 1350 psi and another table was applicable with temperatures of 750 F. Two new tables for cast-iron flanged fittings for 125 psi and 250 psi were added.

The paragraphs on fusible plugs were changed slightly and distinction was made between steam-actuated and fire-actuated fusible plugs.

The Appendix was enlarged to include nine paragraphs, Pars. A-22 to A-30, giving Standard Practice for Making Hydrostatic Tests on a Boiler Pressure Part to Determine the Maximum Allowable Working Pressure.

The suggested rules covering existing installations, Pars. A-31 to A-62 (Part II of 1924 edition) remained unchanged.

The Code was signed by the 23 members of the Boiler Code Committee. Of the members signing in 1927, John A. Stevens and S. F. Jeter had died, and Thomas E. Durban and Charles F. Houston had been made honorary members. LeRoy Mikels and H. B. Oatley had been appointed. There was an addition of one to the Advisory Committee as Evanston, Ill., had adopted the Code.

During the latter part of 1930 and 1931 addenda were published and approved so that fusion welding could be used on power boilers when the 1931 edition was published.

1931 EDITION OF POWER BOILER CODE

This edition contained new paragraphs P-101 to P-111 (13 pages) on Rules for the Fusion Process of Welding. This permitted the fabrication of drums or shells of power boilers "provided the construction is in accordance with requirements for materials and design as required by this Code and the fusion-welding process used conforms to the following specification." After the definitions of fusion welding, and welded joints in Par. P-101, the next paragraph, P-102, gave the efficiency to be 90 per cent when the welds met the requirements of the test of joints with definite types of specimens for tension, bending, specific gravity, and nondestructive tests of the welds in the structure with x-ray apparatus. The materials to be used were given in Par. P-103, and preparation for welding, joints, dished heads, inlet and outlet connections, stress relieving, and hydrostatic and hammer tests were the titles of succeeding sections (Pars. P-104 to P-109). Pars. P-110 on Inspection and P-111 on Distortion completed this new epochal section of the Code. The tests of Par. P-102 were for the purpose of testing the work and proficiency of the welder as much as to determine the adequacy of the material.

This new method of fabrication required a change in the formula for maximum allowable working pressure as the efficiency E now referred to that for welded joints of 90 per cent efficiency, to the computed efficiencies of the riveted joints or ligaments, or to seamless shells, which were now permitted, for which 100 per cent would be used.

This edition recognized the reduction of strength of materials at higher temperatures than 700 F. Table P-5½ gave the values of working stresses at temperatures from 700 F to 950 F with a factor of safety of 5 for steels of different strengths, but at the minimum of the specified range of tensile strengths, to be used for the allowable working pressure for steam pipes or boiler shells.

The subjects of the back pitch, longitudinal and circumferential joints, as well as welded joints, were clarified. Pars. P-197 and 198 on corner radius of dished heads and on manhole openings were combined into the one paragraph, P-197, to give a new formula for the thickness of flat heads in Par. P-198.

Par. P-257, calking, was enlarged to permit fusion-welding for sealing the edges of circumferential joints and on unstayed dished heads.

Specification S25, Open Hearth Iron Plates of Flange Quality, was added to Section II in this edition and a few minor changes were made in Section VI, Rules for Inspection.

The appendix was not changed in this edition except for a minor alteration in one detail on the placing of fusible plugs.

This edition was signed by the same members of the Boiler Code as those appearing in the 1930 edition, with the exception of LeRoy Mikels who had resigned.

SECTION III—BOILERS OF LOCOMOTIVES

The 1931 edition of Section III, Boilers of Locomotives, although published in that year of the recognition of fusion welding contained no further mention of it than that given in 1927 which permitted welding where any load was carried by parts of the structure other than the welded joint. This was probably due to the fact that on locomotives under Federal inspection fusion welding had not yet been permitted.

This edition was signed by James Partington,[1] chairman, F. H. Clark, J. H. Hall, and H. B. Oatley.[1]

SECTION IV—LOW-PRESSURE HEATING BOILERS

The 1931 edition of Section IV of the Code was prepared from addenda, some of which were of a minor nature, to clarify statements of the 1927 edition. Other changes which were made included the transfer of the specification for steel plate for welding to Section II, Material Specifications, the new forms of stamping using the clover leaf with an H in the place of S, the enlargement of Pars. H-40 and H-93 on valves in supply and return mains to provide for size, and the use of tags to designate the use and types. A new figure was inserted in these sections giving a recommended return-pipe connection to the boiler. Pars. H-44 and H-97 on water relief valves were enlarged to clarify the use of such appliances as was also done with Pars. H-55 and H-56, and H-108 on Steam and Altitude Gages. Par. H-64 was changed from one section on fusible plugs to two sections to include one on low water fuel supply cut off although the corresponding Par. H-117 was not changed to include the cut off. Par. H-120 was enlarged to provide for the use of a nonferrous plate for the required stamping when it was not desirable to provide an opening in the casing to view the stamping.

The portion of the Code on Autogenous Welded Boilers was entitled Fusion Welded Boilers and in it only a few changes were made other than those already mentioned. The paragraphs on Filling Material and Material for Base Metal were altered slightly and the table of chemical properties of filling metal was eliminated.

In this edition of Section IV none of the new Rules of Fusion Welding of Sections I and VIII of the Code (1931) were included when it was approved on July 7, 1931. It was signed by Frank B. Howell,[1] chairman, William H. Boehm, Charles E. Gorton,[1] M. F. Moore,[1] W. A. Nevins, W. E. Stark, and J. W. Turner.

SECTION V—MINIATURE BOILERS

The 1931 edition recognized fusion welding by placing the following paragraphs in the Appendix: MA-1 Test Requirements, MA-2 Test Plates, MA-3 Test Specimens. The first fixed the responsibility of the welding on the manufacture, provided for the test on welders at six-month intervals, and permanent records of welders under their given number. The

[1] Member of Boiler Code Committee.

second described the materials to be used in the tests of $^5/_8$-in. and $1^1/_2$-in. plates. The type of joint and the procedure of welding were given in the third section of Par. MA-2. The kinds of specimens and their tests were described in the third section.

This section of the Code, as well as others, provided for the recognition of other materials than those included in Section II when, in the development of the art of welding such became available. Section B and C of Par. M-4 provided for the construction of miniature boilers by welding.

Small changes were made to some of the 20 paragraphs of this Code (M-1 to M-20) to provide that electric heating units could be substituted for washout plugs and that a bull's eye glass could replace the usual water glass when miniature boilers were part of a closed system and the elimination of stop valves in such a system.

Par. M-19 on Stamping of 1924 was made Par. M-20 in 1931, when Par. M-19 became a new provision relating to hydrostatic and hammer tests for welded joints.

This was signed by Charles E. Gorton,[1] Chairman, James Partington,[1] E. R. Fish,[1] C. O. Meyers, Casin W. Obert,[1] and John H. Plunket. W. P. Eales and S. F. Jeter of the subcommittee had died and Mr. William H. Turnman had resigned. C. O. Meyers had been added.

SECTION VI—RULES FOR INSPECTIONS

The Rules for Inspections were usually bound with Section I of the Code. In the 1931 edition small changes were made in Pars. I-19 and I-21 while a new paragraph, I-32*b*, was added on Tolerances for Ellipsoidal Heads including a new Fig. I-2 showing the points for measurement of tolerances.

SECTION VII—SUGGESTED RULES FOR CARE OF POWER BOILERS

The 1927 edition of Section VII was not changed during this period, but on March 22, 1929, F. M. Gibson, chairman of the Subcommittee on the Rules for Care of Power Boilers, reported on a revision of Par. CA-5 in view of the data from the tests of Professors Parr and Straub of the Experiment Station of the University of Illinois. These had been carefully studied by the Subcommittee during the past year. The revision brought this part of the rules more in keeping with the original rules of 1926 and recognized in the first paragraph of CA-5 that cracks from such causes "are in general transcrystalline in character and occur both external and internal to any joint of a boiler." In the next paragraph cracks of a different character were described which occurred in highly stressed portions of a boiler at riveted or other joints and were intercrystalline. These are usually termed embrittlement. A paragraph stated that the analysis of the boiler water when embrittlement occurred showed that the sulphates were low in proportion to the sodium hydroxide and the sodium carbonate. The second paragraph of CA-5 in the 1927 edition was deleted and the introduction to a table of the ratios of total alkalinity to sodium sulphate used the words "in order to eliminate this type of failure," rather than the words which seem to consider embrittlement to be nebulous. The table contained the values of the ratios for boilers with pressures below 150 psi and for pressures from 150 to 600 psi.

This was accepted by the Committee as a revision but on Feb. 27, 1931, Mr. Gibson again came before the Committee to recommend a more complete revision of Par. CA-5 in view of Bulletin 216, of the University of Illinois Experiment Station by Professors Parr and Straub, entitled "Embrittlement in Boilers." The complete revision was given in the report. The report was published and although wide ranges of opinions were manifest in the suggestions received, several specialists outside the Committee expressed such adverse opinions that Mr. Gibson requested the revision to be held in abeyance until a further report could be made. Section VII was not altered until the 1932 edition.

SECTION VIII—UNFIRED PRESSURE VESSEL CODE

The importance of Recommended Procedure for Fusion Welding, by C. W. Obert, to welding for pressure vessels has been shown earlier. Its study and the report on it by the pressure vessel committee of the American Welding Society, which led to the approval by the Subcommittee on Welding and the authorization of its publication in MECHANICAL ENGINEERING on April 13, 1929, justified addenda for Pars. U-23 and U-68 increasing the limiting diameter of welded vessels to 60 in. with a pressure of 200 psi, provided the temperature did not exceed 250 F.

When the procedure was used it also allowed the stress for double-V butt welds to be increased to 8000 psi for single-V butt welds to 6500 psi, and for double full-V butt welds for girth joints to 7000 psi.

During the year 1928 few addenda to the 1927 edition had been formulated, but in 1929 many were made to bring this Section VIII to agreement with the earlier changes made in Section I on Power Boilers. From the addenda sheets the revised form of Section VIII was prepared for publication in MECHANICAL ENGINEERING. It was approved by the ASME Council, Nov. 19, 1930.

In this edition all references regarding materials were made to the specifications in Section II of the Code by new specification numbers. As noted earlier in this chapter the specifications were designated as S-1 to S-24. The limitations of size and working stress were increased when the Recommended Procedure for Fusion Welding of Pressure Vessels was used in the fabrication of the vessel. This procedure was given in the Appendix as Pars. UA-10 to UA-21, each containing a number of separate unnumbered paragraphs.

Some changes were made in the sections on Riveted Joints but under the sections on Dished Heads and Braced and Stayed Surfaces, a large number of changes were made to bring this Section into agreement with those of similar sections of the Power Boiler Code including the new formula for the thickness of the metal for dished heads.

Par. U-57 regarding the strength of rivets in shear around manholes and hand holes was enlarged to include not only the frame or ring but also reinforcements for nozzles and the strength of these rivets in tension. The section on Threaded Openings was now headed Nozzle Openings and increased in extent with parts dealing with the diameter of unreinforced openings giving the formula used in the Power Boiler Section, with a new Fig. U-3 showing four types of nozzle fittings. The enlarged section designated Par. U-59 contained sections on; (*a*) threaded openings and the other nozzle fittings; (*b*) flanged connections; (*c*) expanded connections; (*d*) stress relief; (*e*) riveted connections; (*f*) forge-welded; (*g*) fusion-welded and (*h*) stud-bolted connection.

Stress relief was the name given to annealing in the 1927 Code.

In this edition of Section VIII the official symbol for the stamp to denote the ASME Standard was altered to contain the letter U within the clover leaf in place of the former letter S as described earlier.

Not only were the maximum unit working stresses of the section of the rules for the fusion process of welding increased but most of the Pars. U-67 to U-79 were rewritten, and enlarged, and added paragraphs were made possible by combining the scope of two earlier paragraphs. The figures for methods of welding nozzles were redrawn to include reinforced nozzle outlets and types of fusion-welded nozzle connection not on the

former Fig. U-3 for welded heads and nozzles. A separate Fig. U-7 gave welded head attachments. Pars. U-76 and U-77 were combined as U-77 to form a large section under the caption "Inlet and Outlet Connections" in which new formulas for the diameter of unreinforced openings and the thickness of the reinforcing pads were introduced.

Only the latter part of the paragraphs on Rules for Forge Weldings was changed by rewording but by adding to Par. U-87, the forge welding of nozzles was permitted and Fig. U-9 illustrated the method.

The sections on Rules for Brazing and on Enameled Vessels were unchanged.

An appendix Par. UA-1 to UA-9 was added to this 1930 edition of Section VIII containing the Standard Practices for Making Hydrostatic Tests as well as that on the recommended procedure for Fusion Welding of Pressure Vessels, Pars. UA-10 to UA-21, mentioned earlier in this chapter. This edition was approved by the Committee on Oct. 14, 1930, and by the Executive Committee of the ASME Council on Nov. 19, 1930. This edition of Section VIII was signed by E. R. Fish,[1] chairman, W. H. Boehm,[1] C. E. Bronson,[1] and R. E. Cecil.

1931 EDITION OF SECTION VIII

Following the issuance of this 1930 edition the Committee made further alterations for a new edition and had before them the proposed addition, Rules for Fusion Welding of the Drums of Power Boilers, proposed by D. S. Jacobus, and the proposals of E. R. Fish and C. W. Obert, in which x-ray testing of welds was suggested as well as a breathing test.

At the meeting of Dec. 5, 1930 H. Newell, of the National Fire Protection Association and chairman of a committee of the Compressed Gas Manufacturers Association, was invited to speak to the Committee of the work of his group in developing rules for pressure vessels and with adequate provision for fusion welding. He stated that about 1927 the use of liquefied petroleum gas for domestic purposes became so prevalent that it was necessary for the National Board of Fire Underwriters to draw up regulations for storage equipment. Because these were stationary units, they did not come under the jurisdiction of the Interstate Commerce Commission Rules. Now it had happened that the demand for shipment had become so great that construction rules had become necessary for storage containers, hence the formation of this above-mentioned committee. The committee had considered the Unfired Pressure Vessel Codes, but its limitations to 60 in. diameter and to 200 psi pressure prevented its use as tanks for 55,000 gallons were greater than this limit. As a result the committee had drawn up a set of rules which it would like to have considered in the Boiler Code Committee so as to have such structures come under the ASME Code. He presented the proposed set of rules for confidential consideration and these were referred to the Subcommittee on Unfired Pressure Vessels.

The rules provided for ten classes of vessels using Boiler Code Steels, API pipe-line steels, and ASTM steels. It gave the formula for thickness for different diameters as well as types and efficiencies of joints, heads, outlets, fittings, stress-relieving manhole openings, brazing and weld testing. Much of this was similar to the Code and additions had been made for other parts.

At the meeting on Jan. 23, 1931, the matter of grades of welding was suggested by E. R. Fish, which led to the classifications of vessels for which class one would require x-ray examination of the weld. Other alterations were approved. On Feb. 26, 1931, he was empowered to transfer as much of the recommended procedure as was still applicable to the Code from the Appendix to the Code proper.

The revisions made were published in MECHANICAL ENGINEERING and discussed with thirteen guests from boiler manufacturing companies, the petroleum industry, insurance companies, pipe manufacturing companies, and other engineers on June 26, 1931, and then adopted by the Committee.

APPROVAL OF FUSION-WELDED VESSELS

After discussion and also in consideration of communications from 17 others, the committee voted to recommend to the ASME Council the revisions of the Code for fusion welding of pressure vessels, drums or shells of power boilers as a standard of the Society. The Council approved this on July 7, 1931.

In the 1931 edition of Section VIII the recommended procedure was included in various sections, by rewording or by additional sentences or paragraphs. Parts of the 1930 edition were also reworded or enlarged in scope and a table for allowable stresses at different temperatures was added for steel at the lower tensile strength when the range was 10,000 psi and it conformed to the specifications for steel boiler plate. The efficiencies of fusion welded joints were to be taken from Pars. U-68, U-69, and U-70, while those for ligaments were to be taken from Pars. P-192 and P-193 and those for riveted construction from the rules of Section I. Seamless tubes or drums were allowed 100 per cent efficiency.

To Par. U-27 two paragraphs were added concerning back pitch and Par. U-31 was enlarged to permit the use of lap joints on special portions of a vessel. Pars. U-38 and U-39, dealing with the corner radius and flanged-in handholes, were combined in parts A and B to enable the introduction of Par. U-39 for flat heads at a formula for the thickness of such parts. Par. U-52 on calking was enlarged by a paragraph (*b*) to provide for sealing the calking edges of riveted joints and rivet heads of unfired pressure vessels.

The Rules for the Fusion Welding Process of 1931 covered 28 pages in place of six pages in 1930. The paragraphs were designated U-67 to U-79 in each edition. After defining fusion welding, fillet weld, throat, double-welded butt joint, and single-welded butt joint in Par. U-67, the paragraphs which referred to the Class 1 vessels, appeared as Par. U-68 and extended through 17 pages with lettered paragraphs from (*a*) to (*i*). Some of these lettered parts had numbered and lettered paragraphs in their sections.

The U-68 vessels were those that could be used for any purpose and the efficiency of the x-rayed, stress-relieved weld was given as 90 per cent. The U-69 vessels (Class 2) could be used for any purpose except as containers of lethal gases or liquids. Their thickness was limited to $1^1/_2$ in. and the temperature to 300 F with the maximum pressure as 400 psi. The efficiency of 80 per cent was allowed. The details of the construction of U-69 vessels extended over six pages.

Par. U-70 of four pages referred to another class of vessel (Class 3) which could be used for substances other than lethal gases or liquids for thicknesses not over $^5/_8$ in. when the pressure was not over 200 psi and the temperatues did not materially exceed that of the boiling points of their liquids at atmospheric pressure with 250 F as a limit. In place of fixing efficiencies, the rules of Par. U-70 gave the maximum allowable working stresses for different types of weld joints from 5600 psi to 8000 psi. Par. U-71 listed the specification of available materials.

Par. U-72, Preparation for Welding, a new paragraph, described (in $1^1/_2$ pages) the necessary requirements in 12 paragraphs. Par. U-73, joints, gave the details of longitudinal joints of single or multiple courses, dished heads, concave heads, girth seams, and holes. Par. U-76, Stress Relieving, was more extensive in treatment than Par. U-76, of 1930, as was also true for Par. U-77, Hydrostatic and Hammer Tests.

Inspection, Par. U-78, was new in the 1931 edition as this

subject had been covered in the former Pars. U-69 and U-70 of 1930 in which inspections of the two types of vessels (Classes 2 and 3) were treated separately and the special data sheets required of the manufacturer were defined. The new Par. U-18 referred now to fusion welded vessels.

Par. U-69 contained a statement, that the test by one manufacturer would not qualify a welding operator to do work for any other manufacturer. Test plates by this part of the Code were to bear an identification number given to the welding operator to be used in the permanent record of the results of each operator and kept so as to be available for inspectors. The test plates made of the proper materials of certain grade qualified the operator for that grade only. The sizes of these test plates were defined for the full size tension test, the reduced section tension test, the nick-break test, and the bend test. The minimum requirements of these tests were given as well as the substitution of the x-ray test for the nick-break test for the soundness of the welds of U-69 vessels.

In 1931 Par. U-77, Stress Relieving, had three parts covering the three classes of vessels, U-68, U-69, and U-70. The manufacturer's data sheet for classes U-67 and U-70 was a new requirement.

There were no changes in Rules for Forge Welding and for Enameled Vessels. Some paragraphs in the Rules for Brazing were slightly reworded.

The 1931 edition of Section VIII was signed by E. R. Fish,[1] chairman, W. H. Boehm,[1] C. E. Bronson,[1] R. E. Cecil, and Paul Diserens.

The Committee acknowledged the co-operation of C. A. Adams, J. J. Crowe, E. A. Doyle, F. M. Farmer, F. C. Fyke, and E. N. Ewertz of AWS, F. R. Featherstone, H. E. Rockefeller, H. S. Smith, and H. E. Thomas of the Compressed Gas Manufacturers Association, D. C. Weigel, American Boiler Manufacturers Association, and C. O. Meyers of the National Board of Boiler & Pressure Vessel Inspectors.

Is Your New Product Safe?

(*Continued from page 124*)

investigations to determine, that the brushed rayon, because of its broad surface area of exposure to air, constituted a severe fire hazard. Several boys, wearing the cowboy suits in various parts of the country, were burned severely or fatally when they briefly exposed themselves to fire and the brushed rayon ignited. It burned very rapidly and the boys' clothing was consumed before they could be helped. Similar burnings resulted from the use of brushed rayon for women's negligees and sweaters.

A paint and varnish manufacturer, who produced and sold a wood filler without previously determining its qualities for this use, paid considerable sums of money when a manufacturer of cabinets used the filler and found that after it had dried, it was defective, spoiling hundreds of cabinets.

A candy manufacturer, without testing, purchased a large quantity of paper cups for containing his candy. The packaged candy was put on the market and within a short time it was found that the entire output of the candy in the paper cups was spoiled, owing to a deleterious substance in the paper pulp.

Hazards in new products, therefore, can be costly. So costly in fact, that they may make it impossible for the manufacturer to remain in business, once a potentially dangerous new product reaches the market. An informed and claims-conscious public, laws and regulation, and the reduced opportunity to accumulate profits, make it financially unwise to undertake to manufacture and market a product unless it and its production have been studied thoroughly to identify and evaluate possible hazards.

Handling Coal and Ashes Economically in Smaller Plants

(*Continued from page 129*)

piped either to an air washer or to the stack, whereby the amount of ash discharged to the atmosphere with the steam and air may be minimized.

Water sprays mounted on the unloading chute will help to reduce any dust nuisance when emptying the storage bin. In large pulverized-coal plants, a dustless unloader may be installed below the storage bin for an extra $15,000 in order that the ash may be discharged as a slurry. However, where large-plant refinements of this nature are specified for the smaller ash-handling systems, installed costs may be expected to average $35,000 or $40,000.

A 10,000-ton per year plant averaging 20 tons of ash per week is adequately served with a basic system that costs from $14,000 to $16,000 installed, whereas a 50,000-ton per year plant might justify the elaborate $40,000 system.

SUMMARY OF EQUIPMENT COSTS

Table 2 gives a summary of typical investment costs for complete handling systems well suited to different plant sizes.

TABLE 2 TYPICAL INSTALLED COSTS OF HANDLING SYSTEMS

Coal used, tons/year	Type of handling system: Coal	Ash	Coal silo, tons	Track to silo, tons/hr	Installed cost, dollars: Coal	Ash	Investment, $/annual ton coal
300 2000 5000	Monorail hoist or bin feeder or lift truck		..	..	800 to 3700		2.67 to 1.85 to 1.00
6000	Silo[a]	Hoist	120	25	14000	1000	2.50
9000	Silo[b]	Pneumatic	180	25	20000	12000	3.71
12000	Silo[b]	Pneumatic	240	25	27000	16000	3.58
18000	Silo[b]	Pneumatic	360	35	36000	21000	3.17
30000	Silo[b]	Pneumatic	600	50	42000	25000	2.23

[a] Portable conveyers only from track hopper to elevator.
[b] Includes track hopper and car shaker.

The values shown for investment per annual ton of coal consumption may be used as a reference in analyzing proposals for new installations. These values also can be helpful in analyzing modernization projects because there are many existing installations that would be more expensive to modify than to replace with a completely new system.

CONCLUSIONS

The types and capacities of equipment noted in Table 2 illustrate some of the suggestions for correlating equipment selection and rate of coal consumption. Standardization to this extent has many advantages and might well be incorporated into equipment specifications, keeping in mind that the actual arrangement of equipment may be varied in the individual plant according to the space conditions.

These opportunities for standardization have received very little attention in the past, as may be noted from the fact that many plants have only 1-day coal bunkers while others have bunker capacity for as much as a 6-week supply of coal. Unnecessary extras in one part of a system and inadequate design in another part characterize a great many installations. Improved engineering standards and more careful co-ordination with actual handling requirements will do much to eliminate the notorious inconveniences and extra labor charges that have so often resulted in the rejection of coal as a fuel.

BRIEFING THE RECORD

Abstracts and Comments Based on Current Periodicals and Events

J. J. JAKLITSCH, JR., *Technical Editor*

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context, and credit to original sources is given.

Leading Industry Trends

ACCOMPLISHMENTS during 1952 have been outstanding and in most major fields of activity have surpassed all previous records, according to the December, 1952, "Business Bulletin," published by La Salle Extension University, Chicago, Ill.

The steel industry, the Bulletin points out, is one of the major industries which made the best showing. It continues to operate at well above rated capacity and that capacity is steadily being enlarged. Since getting into production after the long strike, output has been above 2,000,000 tons every week, and about 10 per cent higher than during the corresponding period in 1951. Output in October established a new record of 9,970,000 tons. Total output for the entire year amounted to about 93,500,000 tons, which will be 11 per cent under its all-time high. Demand for steel products is expected to keep operations at close to present levels for several months and no extensive declines are expected. Shortages are steadily being eliminated, however, and some reductions in output can be expected before the end of this year.

Construction, especially of the engineering type, has held up well and monthly outlays were above $3,000,000,000 since the middle of the summer. The current rate is almost 10 per cent higher than it was a year ago. Increases in public construction have been greater than those in private building but both classes show gains over last year. More dwelling units are being started and the total for the entire year is expected to exceed 1,000,000 for the fourth consecutive year. The number will be about 30 per cent less than the peak in 1950. For several years the number of dwelling units started has exceeded the number of marriages and some decline in residential building can be expected. For the most part housing shortages have been eliminated, but demand for good housing will continue as long as incomes remain high. Estimates for total construction this year are for a volume about the same as last year.

The automobile industry continued to turn out cars and trucks at a rate about 25 per cent higher than the reduced rates of 1951. The introduction of new models has been made smoothly, without the usual interruptions for retooling. Weekly output ran close to 150,000 passenger cars and trucks, and is very close to current demand. In addition, the industry is turning out large quantities of military equipment. Close to the current rate of output is scheduled for the first part of this year, provided the materials are available.

The petroleum industry produced at a steady rate about 3 per cent higher than 1951. Average daily production of crude petroleum was above 6,500,000 bbl and current indications are that it may be slightly ahead of demand. No marked decline is expected, however, as the consumers, business, and the Government are using large quantities. Production of coal has been lagging, quite apart from work interruptions. Total output last year has been about 15 per cent less than even the reduced production in 1951. Higher prices which have accompanied the higher costs as well as the continued shift to other forms of fuel and power account for the reduction which is likely to continue.

Production of minerals and metals has risen in recent months and is close to 10 per cent higher than it was in 1951. Shipments of copper to industry have been the highest in five years. Production of aluminum has increased more than 10 per cent during 1952 and output is 30 per cent higher than it was two years ago. Many other metals have made similar gains.

Industries making machinery and industrial equipment are forging ahead. Because more steel has become available, deliveries of new freight cars to railroads have increased, although they were fewer than those a year ago. New orders by railroads have declined and the backlog of orders on hand has been reduced to less than one year's production at the current rate.

The machine-tool industry, the Bulletin notes, is a significant indicator of the future as it represents relatively long-term investments made by industry on the basis of what industrial executives expect future trends to be. New orders for machine tools have been declining steadily from the high points reached two years ago. They are now less than current shipments. On the other hand, production has increased steadily, and is almost double that of a year ago. It is the highest since the peak which was reached during World War II. Unfilled orders

How to Obtain Further Information on "Briefing the Record" Items

MATERIAL for this section is abstracted from: (1) technical magazines; (2) news stories and releases of manufacturers, Government agencies, and other institutions; and (3) ASME technical papers not preprinted for meetings. Abstracts of ASME preprints will be found in the "ASME Technical Digest" section.

For the texts from which the abstracts of the "Briefing the Record" section are prepared, the reader is referred to the original sources: i.e. (1) The technical magazine mentioned in the abstract, which is on file in the Engineering Societies Library, 29 West 39th St., New York 18, N. Y., and other libraries. (2) The manufacturer, Government agency, or other institution referred to in the abstract. (3) The Engineering Societies Library for ASME papers not preprinted for meetings. Only the original manuscripts of these papers are available. Photostat copies may be purchased from the Library at the usual rate, 40 cents per page.

remain large, however, and are equal to about 13 months' production at the current rate.

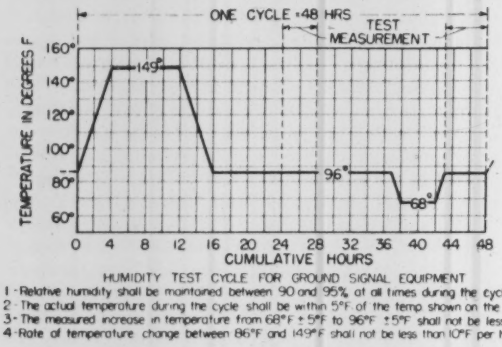
Output of consumer durable goods has been steadily rising as more materials have become available. Demand has also increased and the large inventories in this field a year ago have been reduced to more nearly normal amounts. Especially rapid advances are being made in the production of television sets and production was ahead of 1951 in many types of household appliances. Production of furniture has also increased considerably.

The low rate of business failures is an indication that conditions are favorable for business operations even though costs and taxes are high and many restrictions tend to hamper activities. Both number of business failures and the amounts of liabilities involved were lower than in 1951 and except for short periods the lowest in three years. At the same time, confidence in the future is indicated by the increase in new business corporations which were 10 per cent higher than in 1951.

Environmental Testing

SOME of the most complicated mechanisms known to man such as are used on ships, in the air, in the stratosphere, under the sea, in the tropics, in the Arctic, in the desert, upside down, and in short, under every adverse condition imagina-

FIG. 1 CABINET-TYPE HUMIDITY-TEST CHAMBERS PRODUCE TEMPERATURES FROM 35 TO 180 F AND HUMIDITIES FROM 20 TO 95 PER CENT



HUMIDITY TEST CYCLE FOR GROUND SIGNAL EQUIPMENT

1 - Relative humidity shall be maintained between 90 and 95% at all times during the cycle
2 - The actual temperature during the cycle shall be within 5°F of the temp shown on the chart
3 - The measured increase in temperature from 68°F ± 5°F to 96°F ± 5°F shall not be less than 18°F
4 - Rate of temperature change between 86°F and 149°F shall not be less than 10°F per hour

FIG. 2 TYPICAL CYCLE THROUGH WHICH SPERRY EQUIPMENT IS SUBJECTED BEFORE RELEASE

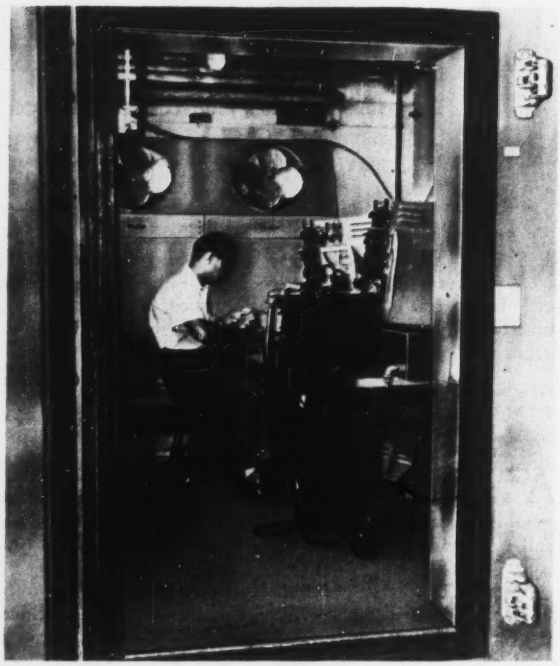


FIG. 3 WALK-IN HUMIDITY CHAMBER FOR LARGE ASSEMBLIES (Part of this assembly is classified and hence blocked out.)

ble, are manufactured by the Sperry Gyroscope Company, Great Neck, L. I., N. Y.

To insure, in so far as is possible beforehand, the successful operation of these products under any conceivable conditions, an environmental test laboratory costing nearly one million dollars has been installed over a period of the past several years.

A wide variety of equipment—from small rubber gaskets to complete units of complicated electronic equipment—is tested in this laboratory. Included in the tests conducted daily are high temperature, low temperature, humidity, altitude, vibration, rain, sand, and dust storms, constant acceleration, tensile, salt spray, shock, and diversified special tests. The general laboratory alone has 28 major pieces of test equipment. A complete new laboratory, for testing undisclosed confidential equipment, already has 20 test units. And overflowing these two areas into an annex is equipment which cannot be fitted into the two main areas.

One of the simpler pieces of test equipment is known as a "sub-Arctic" chamber. In it are tested materials, component parts, subassemblies, and finished units expected to be used under very low-temperature conditions but not under high-temperature, high-altitude, or humidity conditions. This "box" produces temperatures to —95 F.

Two humidity chambers, manufactured by Tenney Engineering, Inc., Newark, N. J., are shown in Fig. 1. These chambers have automatic controls which enable tests to be conducted under variable conditions. A typical test cycle to which ground signal equipment for the U. S. Army must be subjected prior to acceptance is graphed in Fig. 2. Military contracts specify tests to which various pieces of equipment must be subjected and also the per cent of production which must be tested. Fig. 1 also shows how instrument leads are brought through ports in the chamber side to enable attendants to record test data. Rubber stoppers plug the lead openings.

Fig. 3 shows a large walk-in humidity chamber used for testing major assemblies. This equipment, located in the general laboratory, will produce temperatures from —85 F to + 200 F and humidities from 20 to 95 per cent. It sometimes takes as many as four weeks to set up a piece of equipment for test in this chamber. It may then take as many as four months to complete the test. A bombing navigational computer is a typical piece of equipment requiring these extensive tests. Some of this equipment is shown in Fig. 3.

The control panel for the chamber and the instruments which are used in collecting data when the test setup is completed are located directly outside the chamber. In Fig. 4 is shown a Tenney altitude test chamber which simulates altitudes to 80,000 ft, temperatures from —100 F to + 200 F, and humidities from 20 to 95 per cent.

This chamber is serviced by a three-stage Freon-22 refrigeration system. The system has one low-stage, one intermediate, and two high-stage compressors, the high-stage compressors being connected in parallel. Refrigerant gas between stages of compression is cooled by bleeding-in (through an expansion valve) refrigerant from the condenser. Suction gas from the system's subcooler and from refrigerant-cooled valve plates of low and intermediate-stage compressors also is used to cool interstage gas. This enables the compressors to operate at an optimum operating temperature. Cooling coils, heating elements, humidity equipment, and circulating fans are located inside the chamber along the rear wall.

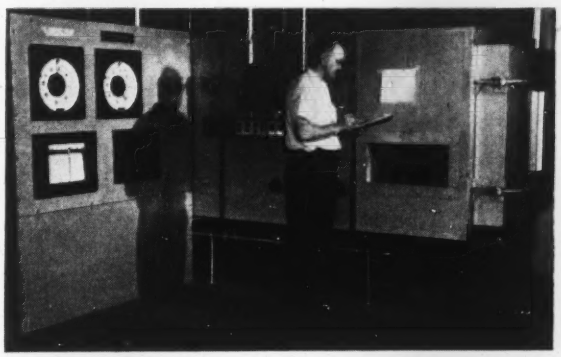


FIG. 4 ALTITUDE-TEST CHAMBER SIMULATES ALTITUDE CONDITIONS UP TO 80,000 FT, TEMPERATURES FROM —100 F TO + 200 F, AND HUMIDITY FROM 20 TO 95 PER CENT

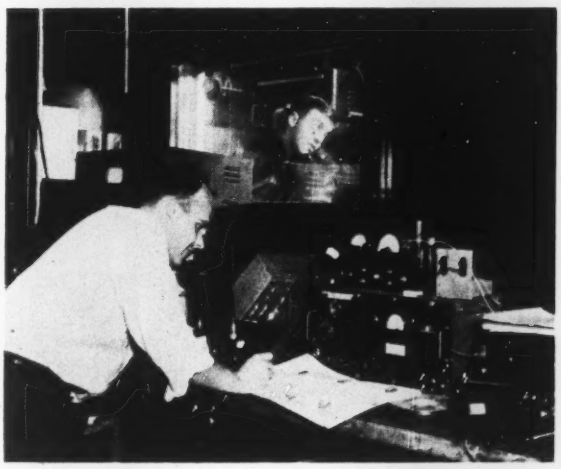


FIG. 5 TECHNICIAN INSIDE CHAMBER COMMUNICATES BY TELEPHONE WITH OUTSIDE ENGINEER DURING LOW-TEMPERATURE TEST

Fans circulate air around cooling coils or heating elements and into the test space. Humidity is produced by introducing water vapor into the air stream. Wet- and dry-bulb thermocouples within the chamber operate control instruments to regulate chamber equipment to produce temperature conditions according to preset values.

A typical low-temperature test in a large walk-in chamber is shown being conducted in Fig. 5. This Tenney chamber, incidentally, is one of the older Sperry chambers, having been installed near the end of World War II. The man inside the chamber is talking with the test engineer on the outside by means of a telephone system. Equipment inside the chamber is operated under actual field conditions, power being brought into the chamber through terminal pads or by power shafts. Equipment outside the chamber includes test instruments from which engineers take readings for making computations and determining whether units on test will perform the function for which they were designed.

This laboratory enables Sperry to predict almost exactly how equipment produced for use in all parts of the world will respond under virtually all possible use conditions. By testing before use, millions of dollars of equipment, hundreds of lives, and uncountable hours are saved, particularly in the case of military equipment.

Decontaminating Plating Solutions

ION exchange, with a long and noteworthy history in the treatment of water for the municipality and the home, is now being used as a new unit of operation by electroplaters. Recently, the attention of various industries, which process metals in solutions, have been focused strongly on ion exchange as a medium for the recovery of metals which, in the past, have gone to waste. Utilizing ion-exchange resins and equipment designed and engineered by The Permutit Company, New York, N. Y., these processes are now said to be economically feasible.

In the electroplating industry, it is almost universally accepted that plating solutions in use become contaminated with impurities, which either reduce electrical efficiency to a serious degree, or cause brittle, spotty, or dull deposits. Ion exchange is used to overcome such problems in hard chromium plating by removing metallic cations from the chromic-acid plating solutions. For this purpose, a high-capacity cation exchanger, resistant to oxidation in chromic acid, is used.

One of the primary causes for some of the electroplating troubles lies in mineral impurities which enter the bath with the water used to make up the plating bath and thereafter to compensate for evaporation and drag-out losses. To overcome this, many platers are installing demineralizing equipment.

A demineralizer utilizes two ion-exchange materials; one a cation base exchanger that is capable of holding calcium, magnesium, sodium, and other cations frequently present in raw water, and the second an anion base exchanger that is capable of holding sulphate, chloride, nitrate, and depending on the type of resin employed, silica and bicarbonate ions. Treatment of the water by these two ion exchangers, either mixed or in series, results in the complete removal of ions (metallic impurities) from the water and enables the water to be used for a wide variety of purposes, where such ions would be harmful.

An interesting application of small demineralizer units is pointed up by the automobile industry where chromium is used to give a satisfactory appearance to trim. Being successful in the General Motors' plants of Cadillac and Pontiac, it should be applicable to other industry as well.

Among electroplaters, it is known that chromium cannot be plated directly upon steel and achieve satisfactory adhesion. It is always necessary to plate on some other metal or prepared surface.

In the automotive industry, the procedure which has been worked out best over a number of years is to plate a layer of copper on the steel, such as a bumper, then nickel upon the copper, and then chrome upon the nickel. The copper provides adherence to the base metal, and the nickel provides excellent corrosion-resistance, while the chromium provides the final hard, bright, long-wearing finish.

During the present emergency, supplies of nickel for intermediate plating steps were cut off to manufacturers of consumer goods and they were forbidden to use nickel for this purpose. The second part of this government order has now been lifted and manufacturers are again permitted to use nickel, although no supplies of the nickel or nickel salts have been allocated for such use.

In order to obtain satisfactory corrosion resistance without the use of nickel, it was necessary to cover the chromium with a clear organic lacquer. It was further discovered that it was impossible to achieve satisfactory adherence of this coat of lacquer when the final rinse, following the chromium plating, contains any appreciable quantity (no more than 10 ppm) of salt. A subsequent chromate treatment in a dilute chromic acid or dichromate solution, which seals the plated surface, is frequently effective in assisting adherence. However, the dichromate or weak chromic-acid bath is most effective when made up with demineralized water. For this reason, automobile manufacturers and others are providing demineralizing stations to provide high-purity water for the final rinse. In this application, the water is used on a once-through and throw-away basis, and there is no chromium or water recovery. The demineralized water is also used for plating bath make-up.

Ion exchange is also recognized as the only method of treating many electroplating rinse waters to render them nontoxic and to recover small quantities of valuable metals in these waters for subsequent re-use. It makes possible a plating room with a closed plating circuit. It eliminates the waste-disposal problem, recovers valuable chromates formerly sent to waste, and provides demineralized water for the plating room. The same system is widely used by anodizers, who treat aluminum for aircraft in a chromic-acid bath, in a method similar to electroplating, in order to provide greater corrosion resistance to the aircraft.

Grinding Research

VALUABLE data on grinding, of considerable importance to both engineers and production management, increasingly are becoming available as the result of basic research being conducted at Mellon Institute by the L. Leslie Byers Memorial Fellowship sponsored by the Grinding Wheel Institute.

Currently, the research seeks to answer the question: "What happens to a surface when it is ground?" Some of the important results of the project to date are as follows:

1 Better techniques have been developed for studying the residual or "locked-in" stresses in surfaces. The practical importance of such stresses is that they may affect the service life of many important manufactured parts. The effect may be beneficial or detrimental, depending on the type of stress, its magnitude and location in the part, and the forces to which the part is subjected in use.

2 Considerable information has been obtained through investigation of residual stresses in surfaces generated by abrasive action. Like all mechanical methods of generating surfaces, grinding induces residual stresses.

3 In the case of abrasive wheel grinding, these stresses may be either tensile or compressive, depending upon direction and the depth below the surface. The thickness of the stressed layer, which has varied from about 0.002 in. to more than 0.040 in. in experiments conducted to date, depends upon the composition of the steel, its heat-treatment, and the severity of the grinding. The highest stresses usually lie well within 0.001 in. of the surface in this type of grinding.

4 Lapping with loose abrasive induces compressive stresses in steel surfaces which extend a few ten-thousandths of an inch into the metal.

5 Barrel finishing with abrasive grain induces predominantly compressive stresses in steel surfaces.

6 Preliminary studies of residual stresses in glass and plastic have shown that these materials are similar to steel in their reaction to grinding.

7 Valuable information has been accumulated concerning the residual stresses resulting from the heat-treatment of steel.

Future plans call for an extension of the experiments to include methods of alleviating grinding stresses when they are detrimental, and fatigue studies to determine their effect upon service life.

Other research projects currently are in the planning stage, each geared specifically to the objective of yielding useful information on grinding, especially the use of the grinding method in large production operations.

Abrasive-Belt Grinding

AS A result of co-operative engineering between Behr-Manning Corporation of Troy, N. Y., and Fenlind Engineering Company of Rockford, Ill., a new method of sharpening tungsten-carbide cutting tools without a diamond wheel has been developed. Costs are claimed to be approximately $^2/_3$ less per tool sharpened than the conventional diamond-wheel method and a longer-lasting cutting edge on the tool is produced. The machine for the new method uses as a grinding

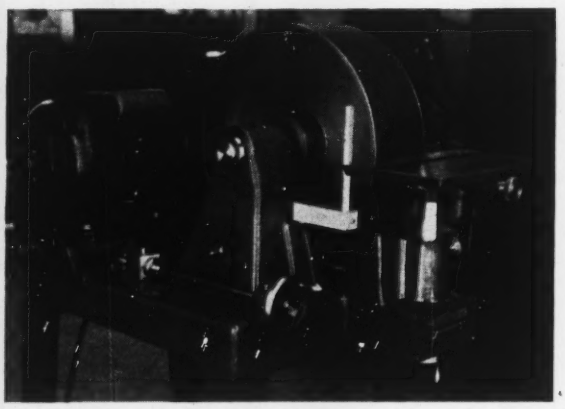


FIG. 6 TURNED FROM SPECIAL CAST IRON OF EXCEPTIONAL HARDNESS, THE CONTACT WHEEL ON THE CARBIDE TOOL GRINDER SUPPORTS A WATERPROOF ABRASIVE BELT OF SILICON CARBIDE ON PAPER BACKING

element a coated abrasive belt that travels over a cast-iron contact wheel specially formulated for extreme hardness.

The new development, it is believed, removes the urgent need for diamond grinding wheels now in critically short supply. Also, because of its lower operating costs and the better cutting edges it produces, it makes tungsten-carbide-tipped cutting tools available to an estimated 60,000 small shops which cannot afford the diamond wheels previously necessary for sharpening purposes.

Field tests by Behr-Manning engineers show that belt costs for sharpening tungsten-carbide tool bits range between one and three cents per tool. Sharpening carbide tools by the conventional method costs six to 17 cents per tool sharpened. In addition to reduced costs of materials, the abrasive-belt procedure eliminates two traditional steps without sacrificing cutting-tool performance. With the new method, the intermediate grind and the finish-honing operations are no longer necessary, it is reported. After the clearance angle has been rough-ground on the tool with a silicon-carbide wheel, the relief angle and final cutting surface can be microfinished in one operation with the coated abrasive belt.

Tests indicate that working life of tungsten-carbide-tipped

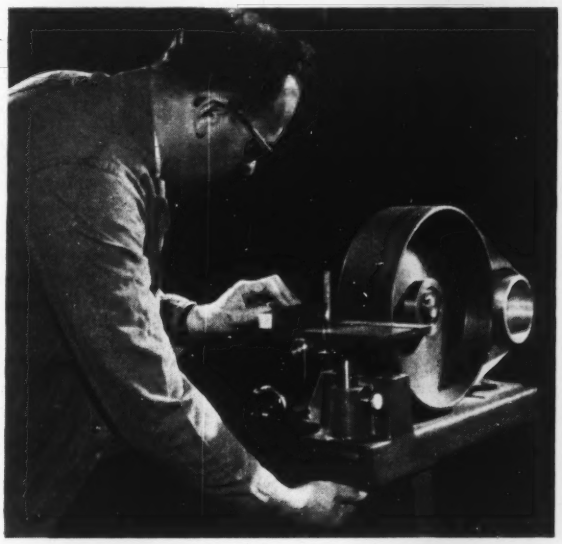


FIG. 7 ADJUSTING WORKTABLE HEIGHT FOR GRINDING DESIRED RELIEF ANGLE ON CARBIDE TOOL

cutting tools sharpened by a coated abrasive belt average about double the life of those sharpened by conventional methods. In one controlled test made on a production line turning 5665 nickel alloy, the carbide turning tools sharpened by diamond wheels averaged 12 pieces per resharpened tool. In contrast, those sharpened by a coated abrasive belt completed an average of 34 pieces before resharpening was required. In another shop where parts made of AMS 5060 steel were being machined, diamond-wheel-sharpened carbide tools produced 120 pieces but the belt-ground tools turned out an average of 202 1/3 pieces per resharpened tool.

The comparatively finer finish produced by the abrasive belt on the cutting face of the carbide tip accounts for the extended tool life. A finish of 2 to 16 microinches rms is put on the tool by the 220-grit belt. In addition to the better finish it produces, the belt method does not produce chipping on the cutting edge of the tool that must be honed off with a diamond

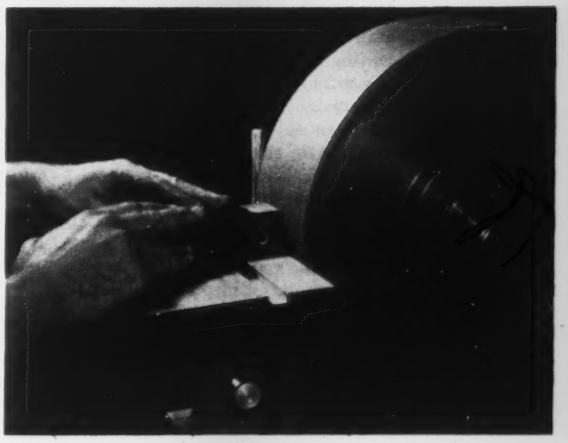


FIG. 8 CURVATURE OF THE CONTACT WHEEL AT A POINT CORRESPONDING TO THE DESIRED ANGLE MARKED ON THE CALIBRATED POSTS PRODUCES RELIEF ANGLE AND LIGHT PRESSURE AND A 2 TO 3-SECOND GRIND PRODUCES THE REQUIRED CUTTING EDGE

hone when carbide-tipped tools are sharpened by conventional methods.

The machine that makes possible this method of sharpening carbide-tipped tools is called the Fenlind Micro-Finisher. The waterproof silicon-carbide paper belt (Speed-wet Durite) is driven by a 14-in. cast-iron contact wheel. The height of the worktable can be adjusted in relation to the contact wheel to permit any normal relief angle to be microfinished on the carbide cutting tool.

The relief angle is set by adjusting the height of the table until the face of the cutting tool contacts the belt on the periphery of the contact wheel at a point on its curvature that corresponds to the relief angle desired. A vertical gage, marked in degrees from 1 to 22, is mounted near the table at the left of the wheel. Proper table height is established for a desired relief angle by aligning the cutting edge of the carbide tip with the correct angle marking on the vertical gage.

The procedure for sharpening carbide-tipped tools with the belt method involved two steps: First, rough-grind the clearance angle with a silicon-carbide grinding wheel; second, with the belt machine table set to produce the correct relief angle, microfinish both front and side relief angles of the tungsten-carbide tool, and microfinish the nose angle by swinging the tool through approximately a 90-deg arc. Light manual pressure is adequate to produce a fine finish and no edge of the cutting tool need be held against the belt for more than two or three seconds.

Continuous-Casting Machine

A NEW machine that continuously casts steel billets or slabs will be commercially installed at Welland, Ontario, Canada, within a few months.

Koppers Company, Inc., and Atlas Steels Ltd. of Welland, announced details of a contract by which Koppers will design and construct a continuous ferrous-metals casting machine to produce tool, stainless, and other high-grade steels. This development, it is said, will yield from 10 to 15 per cent more finished steel per heat than conventional pouring methods.

With an uninterrupted supply of molten metal, the new machine would be capable of casting a continuous billet or slab

of indefinite length. In actual practice, automatically moving acetylene torches will cut the metal into usable lengths as it emerges from the casting machine.

Continuous-casting machines are particularly desirable since in certain specific applications, especially in small and medium-sized plants, such machines will allow by-passing of the blooming mill and soaking pits in the steelmaking operation with sizable cost savings.

Operation of the continuous-casting machine starts, of course, with adequate facilities for melting. From these facilities the molten metal is transferred to the machine and poured into a refractory-lined vessel. This vessel or tundish has a nozzle at the bottom which directs the metal into a copper mold.

The walls of the copper mold contain drilled passages through which water is circulated in order to extract the heat from the solidifying metal. An essential part of the process is the mold oscillation in which the mold moves downward with the casting for a certain distance and then returns quickly. This action keeps the metal from sticking to the mold as it hardens and increases the mold efficiency.

In order to start the casting operation, a dummy billet or slab of nearly the same cross section as the casting is inserted halfway into the mold from the bottom. The end of the dummy in the mold is packed to prevent molten metal leaking down the sides as the first metal is poured into the mold. When the mold is nearly filled, the machine is started, the pinch rolls draw down the dummy with the new formed casting attached, and continuous casting is under way.

As the casting emerges from the bottom of the mold, it passes through water sprays which complete solidification and through withdrawing rolls which control the speed of casting. Below these rolls is the acetylene torch which automatically cuts the casting to desired length.

From the cutting torch, pieces are received by a mechanical device which delivers them from the pit beneath the machine to a conveyer above ground. The discharged pieces are now ready for conditioning if necessary, reheating, and rolling to finished sizes.

Koppers will build the continuous-casting machine for Atlas Steels at its Metal Products Division in Baltimore, Md. This machine will produce $4^1/_4 \times 4^1/_4$-in. billets; $5^1/_2 \times 7^1/_2$-in. billets; and $5^1/_2 \times 21^1/_2$-in. slabs.

With different molds, the machine also could produce rounds. The Atlas Steels machine is capable of casting at speeds from 0 to 100 ipm. Metal flow is regulated by increasing or decreasing the level of the molten metal in the tundish above the mold.

Height of the machine will differ in various installations depending on the cross section cast and length of pieces cut. In the Atlas installation, the height from plant level to machine operating floor is 30 ft.

Salvaging Porous Castings

THE salvaging of porous castings by means of a new combination of sealing materials and impregnation methods is said to make possible for the first time 100 per cent "filling" of microporous voids in metallic castings, on a production-line basis, according to Polyplastex International, Inc., New York, N. Y.

A study of currently available sealants by Polyplastex research men indicated that they were all of a low-solids type, ranging from 30 to 50 per cent solids and 50 to 70 per cent volatile content. Low sealing efficiency resulted, they pointed out. For example, if 10 cc of a 50 per cent solids sealant were impregnated in a casting and cured, only 50 per cent of the sealant remained in the pores, while 50 per cent evaporated, leaving a spongy cellular structure of poor physical properties. The Polyplastex method utilizes a 100 per cent solids sealant, they said, thus insuring a high degree of sealing efficiency at a low production cost.

The process is based on the use of a specially formulated thermosetting resin. Known as Polyplastex MC, the resin is distinguished by the fact that it is 100 per cent reactive—that is, all of the sealant converts into a solid of excellent physical and chemical properties. Thus, when the liquid resin fills all of the pores, it occupies the same volume after it becomes solid.

The impregnating resin is resistant to a wide variety of solvents, water, salts, hydrocarbons, and glycols, as well as acids and weak alkalies. The cured resin can withstand continuous exposure to temperatures up to 350 F. Although it is hard, the resin is yet resilient enough to allow for expansion and contraction of the metal due to variations in temperature.

Leaking castings can be salvaged by one of the following methods: (*a*) External vacuum; (*b*) internal pressure; (*c*) internal vacuum; or (*d*) vacuum and pressure—the most commonly used method. This latter method utilizes a vacuum-pressure tank in which the castings are placed. The tank is closed and a minimum vacuum of 29 in. (mercury) is applied. The sealant is brought into the tank to cover the castings and 100 psi of air pressure is applied to the fluid head, forcing the sealant into all microporous areas. After impregnation, the castings are removed from the tank, their surfaces cleaned, and finally put into an oven to be cured. No surface stain or film is said to be left by the process, so that the properties of the casting are not in any way impaired.

Both ferrous and nonferrous metals can be economically processed by the method. Perhaps its greatest use is in aluminum and magnesium castings, since microporous flaws are particularly prevalent in low-density metals. The Polyplastex materials embody the ideal properties required for impregnating magnesium castings as reported by a committee of the Society of Automotive Engineers. These include: (1) Thermosetting (infusible on reheating), (2) insolubility in gasoline, (3) low viscosity in the monomeric state, (4) chemical inertness to magnesium, (5) toughness of polymer, (6) low toxicity, (7) low cost, (8) readily available, (9) good penetrating qualities, and (10) slight expansion on polymerization.

Corrosion-Resistant Alloys

ANNOUNCEMENT was made recently by Aluminum Company of America of two alloys, highly resistant to corrosion, which are particularly designed for use in welded assemblies (such as pressure vessels), tanks, and highway transportation equipment. These alloys, designated XA54S and XC56S, are sent to permit use of section thicknesses approximately one half or less of other aluminum alloys commonly used for similar purposes.

The alloy XA54S belongs to the aluminum-magnesium alloy family and has mechanical properties between those of 52S and 56S. Sheet and plate are available in the annealed and intermediate work-hardened tempers.

XA54S is well-suited for such applications as welded ship superstructures and barges; pressure vessels and heat-exchanger shells, used in connection with tonnage-oxygen plants and the manufacture of fertilizer solutions; and for liquid and bulk-hauling equipment such as tank trucks and trailers, dump trucks, and other special-purpose equipment.

Presently being constructed of XA54S are seven 44-ton-capacity bottom-dump coal-hauling trailers for open-pit-mining operations. These trailers, with a 62-cu-yd capacity, will be loaded by power shovels.

A 6000-gal welded tank trailer has been constructed for an oil company. Design studies indicated that by the use of XA54S alloy, approximately 2500 lb weight-saving could be made, which would permit an additional payload of 400 gal without exceeding weight limitations. The first welded-aluminum bulk-cement hauling trailer has recently been completed, it is reported.

The alloy XC56S is similar to the Alcoa 56S alloy used extensively for wire products and venetian blinds, except that the composition has been altered to improve its welding characteristics. It is recommended for general use in the annealed (-O) and hot-rolled (-H112) tempers.

XC56S is suitable for various types of welded structures where strengths higher than those obtainable in 52S and XA54S alloys are required. Commercial evaluation of XC56S has not been carried as far as XA54S but laboratory tests indicate that in the annealed (-O) and hot-rolled (-H112) tempers, XC56S has weld strengths about 25 per cent higher than XA54S in these same tempers.

Both alloys are weldable using inert-gas metal-arc process (argon tungsten) or the semiautomatic inert-gas metal-arc process. The welds are ductile and have high elongation.

Zirconium Tests

RESULTS of numerous miscellaneous high-temperature experiments with zirconium and zirconium compounds conducted by the Bureau of Mines, United States Department of the Interior, are presented in detail in a report released recently by the Bureau.

The report describes early tests made in connection with the Bureau's recent development of an economical method of producing ductile zirconium. Most of the information it contains may be applied with virtually no change to problems involved in producing another of the newer metals, titanium.

Zirconium metal, easily drawn into wires and rolled into thin sheets, is used widely in electronic tubes, as well as in electric condensers, lamp filaments, flares, photoflash bulbs, and ammunition primers. It imparts strength and resistance to corrosion to the many valuable alloys it forms.

Among the many problems investigated by Bureau metallurgists and described in the present report are: The decomposition of zircon to produce anhydrous chloride; the direct production of alloys; plating of pure zirconium and zirconium alloys on various metals; and the behavior of zirconium compounds at elevated temperatures in various gaseous media.

The report contains a bibliography of literature on zirconium, and an appendix describing experiments with a method that employs chlorine for oxygen determination in zirconium, 8 tables, and 5 illustrations.

A free copy of Report of Investigations 4915, "High-Temperature Experiments With Zirconium and Zirconium Compounds," may be obtained from the Bureau of Mines, Publications Distribution Section, 4800 Forbes Street, Pittsburgh, Pa. It should be identified by number and title.

Flame-Plating

A NEW method for applying hard, thin, precise coatings of powdered metals, such as tungsten carbide, on metal parts, called Flame-Plating, is being used to help solve frictional and abrasive wear problems—no matter how common or how unusual the problem may be. Developed by Linde Air Products Company, a Division of Union Carbide and Carbon Corporation, New York, N. Y., extensive tests to date with Flame-Plating indicate that Flame-Plated tungsten-carbide coatings have the desirable properties of sintered tungsten carbide, while at the same time avoiding some of the limitations of the sintered form. Tests have shown that the coatings have wear and abrasion resistance that is as good as, or better than, sintered carbides. Although several coating materials are being tested for use with the Flame-Plating process, much of the initial work has been done with tungsten carbide, and all present commercial applications use this material.

It is pointed out that one of the biggest features of this new method is that the temperature of the base metal does not exceed 400 F, during the plating operation. This low-temperature deposition practically eliminates any possibility of a change in the properties of the part being plated, and reduces to a minimum the chance that the part might warp.

The bond between the base metal and the coating is mechanical—it is not a welded bond. Because of the unique way in which the coating is applied, there is no mixing of the coating with the base metal.

The method is adaptable to many different base metals in a wide variety of sizes and shapes. Steels, cast iron, aluminum, copper, brass, bronze, titanium, and magnesium have all been successfully coated. Flat areas, cylinders, spheres, internal areas, and many irregular shapes have been coated. Tungsten-carbide coatings from 0.0005 to 0.020 in. thick are currently being applied. Flame-Plated coatings are available for literally hundreds of applications—precision tools and gages, well-drilling equipment, engine shafts and bearings, cotton-picking spindles, and many others.

When any metal part is Flame-Plated, the base metal, it is reported, retains its properties. If copper is Flame-Plated, it has good electrical conductivity; but, at the same time, it resists surface wear. If magnesium or aluminum is Flame-Plated with tungsten carbide, a lightweight part is produced that has wear resistance equal or superior to sintered tungsten carbide. Flame-Plated steel parts are tough enough and strong enough to withstand loading, and have excellent resistance to severe frictional and abrasive wear.

Parts to be Flame-Plated are undercut just deep enough to allow for the desired thickness of the coating. A small protective lip of base metal is usually left at any sharp edge where the part may be subjected to abuse or where two Flame-Plated surfaces meet at a sharp angle.

After a coating is applied, it can be ground and lapped to a finish of approximately 2 microinches rms. Finish specifications are determined by the requirements of the part. Some applications, such as the teeth of a circular saw blade or the barbs of a cotton-picking spindle, do not require any grinding. The surface finish of as-coated tungsten carbide applied by Flame-Plating is approximately 125 microinches rms.

Resinoid-bonded diamond wheels are the only grinding wheels suitable for finishing a Flame-Plated surface. A 100-mesh wheel is used for rough-grinding and a 400-mesh wheel for finish-grinding when no more than 0.005 in. is to be removed. Before and during grinding, the part is flooded with a suitable coolant.

There is a wide variation in the present charges for Flame-Plated coatings because costs are greatly influenced by several factors, including size and shape of area, thickness of deposit, and quantities involved. Prices range from about 70 cents per sq in. to about $10 per sq in., depending upon these variables. In terms of comparative costs, Flame-Plating falls somewhere between the cost of a hard-faced part and a sintered tungsten carbide.

In balancing the cost of Flame-Plating against increased service life, no exact comparison is possible because of many factors. In the case of burnishing tools used to produce auto-

motive parts, for instance, Flame-Plated burnishers produce about 20 times as many parts as chrome-plated burnishers. The cost of a Flame-Plated burnisher is increased only 4 times. In addition to the savings in burnishers themselves are the added savings from reduced down time and reduction in number of out-of-size parts produced by worn burnishers.

Flame-Plated core rods are said to have about a 12 to 1 advantage over tool-steel core rods that have been hard-chromium-plated. Flame-Plated plug gages outwear sintered-tungsten-carbide gages by a factor of about 3 to 1—and Flame-Plated plug gages are less expensive. Other parts that are being tested include shafts and bearings, draw dies, balls, thread gages, paper-slitter knives, valve plugs, seat rings, and pump plungers.

Rotating Machine

A ROTATING machine, said to be the largest ever built, is being assembled by the Westinghouse Electric Corporation. It consists of the five compressors and drive for the transonic and supersonic wind tunnels being built for the U. S. Air Force at Tullahoma, Tenn.

Four motors with a combined power of 216,000 hp are required to drive the compressors. Two of these are synchronous motors, each being nearly one third larger in horsepower than the 65,000-hp pump motors recently installed at Grand Coulee Dam.

The supersonic compressor for the wind tunnel will consist of four compressors in series, while the transonic compressor will be a single unit. Statistics on the inlet-stage blades of the transonic compressor suggest the scale of this super wind maker. Each blade is more than 2 ft across the face, 6 ft long, weighs almost two thirds of a ton, and rotates at 600 rpm on a spindle 18 ft in diam. The tip speed for this great mass is 650 mph and the centrifugal force tending to pull each blade from its roots is 800 tons. The blades are solid forgings and are rooted to disks that are the largest that can be forged anywhere in the world.

A quarter-scale model of one of the multiple-stage compressors has been built. This model underwent exhaustive tests to insure that the blades will not develop resonance at operating speed. Resistance strain gages and an associated electronic circuit were used for observation of the vibratory characteristics of the blades under operating conditions.

The two liquid rheostats for motor speed control were also reported to be the world's largest. These will be used for secondary control of the two wound-rotor machines during starting, load transfer, and the like, and each is capable of a peak dissipation of about 25,000 kw. The nickel-clad-steel electrodes are 3 ft in diam. Although the machine represents the highest stored energy of any rotating mass ever built, it can be brought to a halt in about three minutes by using the wound-rotor motors as brakes, dumping energy into the liquid rheostats.

The problem is not only to get energy into the air stream but also to get it out again. The air stream would become enormously hot without the large cooling system provided by Stacy Brothers. Even with 100,000 gpm of water flowing through coolers the air discharge temperature is above 600 F. The air in the test chamber, on the other hand, will be down to about 100 F below zero.

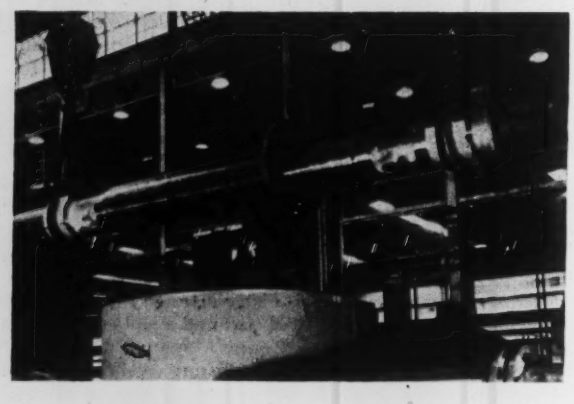


FIG. 9 ROTOR SHAFT FOR SYNCHRONOUS MOTOR

FIG. 10 ROTOR BLADE FOR TRANSONIC COMPRESSOR

Continuous Rappers

ELECTRODE rapping is an essential part of electrostatic precipitator operation and maintenance. Precipitators are used to clean gases from blast, open hearth, electric, and iron-ore sintering furnaces. They have proved highly efficient in the job of reducing nuisance emissions and in recovering valuable suspended materials otherwise lost to the atmosphere.

The gas-cleaning work is done chiefly by the precipitator's electrodes. There are two sets of these electrodes in a precipitator shell, the high-tension discharge electrodes, and the collecting electrodes. The gas to be cleaned flows through the electrical field set up by the discharge electrodes. Suspended materials in the gas become electrically charged and attracted by the grounded collecting electrodes.

A recent development by Research Corporation, Bound Brook, N. J., manufacturers of Cottrell precipitators, now offers precipi-

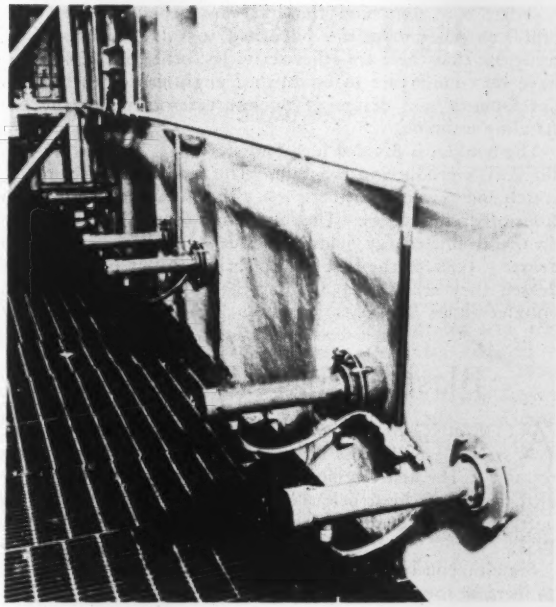


FIG. 11 SIX MI RAPPING UNITS ARE SHOWN IN THIS INSTALLATION (Up to 24 of these rapping units can be energized from one supply source. MI rappers continuously rap electrostatic-precipitator plates to prevent dust build-up on high-tension discharge electrodes and collector plates and provide an automatic means for efficient precipitator efficiency.)

tator users a rapping system for continuous electrode cleaning. It is a magnetic-impulse (MI) rapping system which delivers continuous rapping impacts of light and easily controlled intensities. The MI rapping method uses a solenoid-actuated rapper energized by a pulse generator, instead of a mechanical or pneumatic rapping device as in other rapping systems.

The MI rapper, it is said, can be easily installed on any standard electrostatic precipitator used in electric, blast, cupola, open-hearth, and iron-ore-sintering furnace installations, and for fly ash, gypsum, and cement applications as well.

A central pulse generator can deliver tripping impulses to each of the rapping units—up to 24 per precipitator—at intervals of $2^1/_2$ sec to rap the entire precipitator in 60 sec or less. Power consumption is low—300 watts or less per precipitator. This means low operating cost and low power capitalization costs. A separate remote-control unit permits monitoring of the rappers from any convenient plant location to eliminate the need for any regular operating personnel.

Other advantages include: More efficient precipitator performance, automatic control of the rapping system, complete elimination of stack dust which can occur periodically during rapping periods in mechanical and pneumatic rapping systems, and rapping-equipment noise is completely eliminated.

Vibroflotation

WHAT is said to be the first large plant in the United States to be constructed on sand compacted by Vibroflotation will be completed early this year at Bonnie, Fla., for the International Minerals and Chemical Corporation of Chicago, by the Rust Engineering Company of Pittsburgh and Birmingham.

A saving of $250,000 was achieved by the method which enabled the Bonnie Phosphate Chemicals Plant to be constructed on dry wasteland sands with no support other than the sand itself. The entire plant will cost $12,000,000.

Key to the new practice of building on sand is a sand compaction process called Vibroflotation.

The Vibroflotation process, it is pointed out, increases the relative density of sandy soil by a shaking and pushing process that packs the sand grains more closely and tightly together and reduces the voids or empty spaces between the particles. A much more solid sand mass results.

The device used, called a Vibroflot, consists of a tube which is vibrated by an electrically driven eccentric inside it. A 10-ton centrifugal force is produced. This apparatus is attached to a follow-up pipe which houses required water and electric lines.

In operation the Vibroflot is suspended from a crane and guided by vertical wooden leads. Vibrating at full speed, it is lowered into the sand while a water jet at its tip forms a saturated sand mass or temporary "quick sand" condition, into which the vibrator rapidly sinks.

Lowered to an average depth of 13 ft at Bonnie, the device by its vibrating action pounds the sand surrounding it into a tighter mass on all sides. Fresh sand is shoveled in from above to fill the extra space emptied by this compaction.

The vibrator is withdrawn in one-foot stages, being run at each until the sand is packed as solidly as practical at each stage. An average of $2^1/_2$ cu yd of fresh additional sand is added by the time it is fully withdrawn. The result is a tightly compacted sand column about 8 to 10 ft in diam. The columns are pounded in predetermined overlapping pattern with about 8

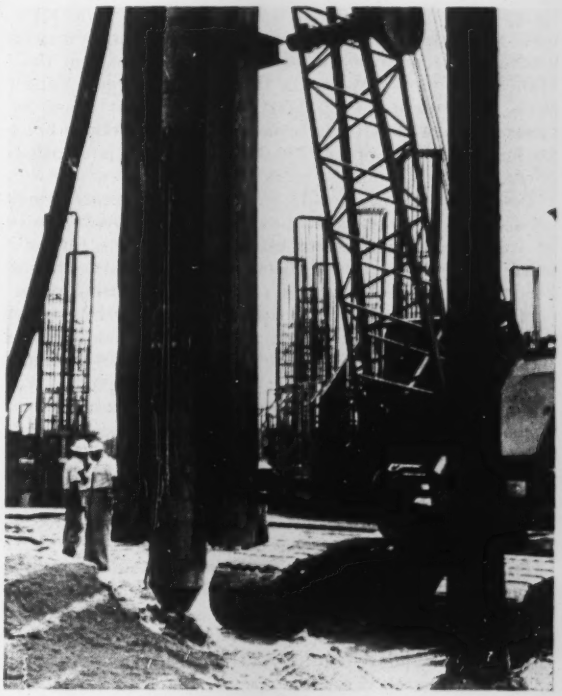


FIG. 12 CLOSEUP OF THE VIBRATING END OF THE VIBROFLOT (In the upper half is housed an electric motor which drives an eccentric shaft located in the lower half. Revolving at a high speed, this eccentric generates a 10-ton centrifugal force that produces the powerful vibrations required in the Vibroflotation process. A displacement of about $^3/_4$ in. in each direction off center is facilitated by the universal joint between the Vibrator and follow-up pipe.)

ft between centers. The pattern greatly strengthens the compaction results which give a relative density of 70 to 100 per cent—more than enough for high or very high bearing capacity.

The complete compaction at Bonnie Plant took two crews 160 days for some 3350 compactions. Results show, after six months, that one of the first structures completed, the phosphate storage building, has experienced no measurable settlement. Advance estimates had allowed for a maximum settlement here on the order of one inch.

Rust Engineering sees a future for this technique in construction of earth dams, cofferdams, levees, and airport construction in sandy areas, as well as heavy industrial plants with vibrating equipment. Another special use is in water-retaining dams and underwater structures where Vibroflotation concrete can create unusually tight structures.

Atomic-Energy Summary

A SUMMARY of the U. S. Atomic Energy Program is given in a 48-page booklet, "Uranium, Plutonium and Industry," recently published by The American Society of Mechanical Engineers and available at $1.50 per copy. This new booklet, compiled under the auspices of the ASME Nuclear Applications Committee, is actually a revision and enlargement of an informal survey of the atomic-energy field, entitled, "Catching Up on Atomic Energy." This informal survey was prepared by Waddell & Reed, Inc., at the request of Vitro Corporation of America, as a public service.

According to the ASME survey, the U. S. Atomic Energy enterprise started officially in February, 1940, when $6000 was made available by the government for the purchase of materials needed for laboratory studies of nuclear fission. In the 12 years which have passed since then atomic-energy appropriations have totaled $12,000,000,000, and what must have seemed at the time a fairly tenuous laboratory activity is now an industry that employs 150,000 people and is distributed over a land area of 3000 sq miles.

Despite its size, the booklet states, the atomic-energy industry does not have the status of such industries as coal, or paper, or steel. It is not private industry. Closely regulated by federal law, which presently bars private ownership of fissionable materials and of facilities capable of producing them in significant amounts, it is financed by the government and managed by a government agency. How long these conditions will continue to prevail is problematical. While government control can be expected to last as long as the present world situation lasts, it is the policy of the U. S. Atomic Energy Commission to encourage private initiative to the fullest extent permitted by law. Some private capital has already been invested and the indications are that private initiative will increase markedly when atomic power and other industrial applications of atomic energy have been developed to a point where commercial markets can be established.

Private industry has participated in the atomic-energy program on a very large scale on a contract basis. All of the major production facilities have been designed, built, equipped, and operated by industrial concerns, and a substantial portion of the research and development program has been carried out by industrial research organizations. Today with the rapid expansion of the AEC program, the list of AEC contractors reads like a directory of American industry.

The booklet attempts to give the broad pattern of the atomic-energy industry as it exists today. The engineer will recognize many of the activities as either a direct application or an extension of the familiar fields of chemical, mechanical, or electrical engineering. The setting is new but the problems—heat transfer, corrosion, and the like—are generically the same problems other industries have had to solve. He will also recognize that there are other activities, other problems which have no counterpart in established engineering practice, the development and design of nuclear reactors being the outstanding example.

The booklet is divided into four sections. The first outlines the AEC's production program. The second sketches the research and development network. The third discusses applications of atomic energy. The fourth lists sources of information on the atomic-energy field. All four sections are highly condensed. Perhaps the best way of bringing out just how condensed they are is to point out that for every word in the booklet about $1,000,000 has been invested in the industry.

Blast-Furnace Expansion

ACCORDING to *Steel Facts*, December, 1952, five gigantic new blast furnaces were brought into operation in this country in the first ten months of 1952, two more were scheduled to go into blast before the end of the year, and 11 other units are being advanced toward completion in the first half of 1953.

Simultaneously, improvements have been and are being made to increase the output of a number of older furnaces. All told, this phase of steel expansion is said to be the greatest and most costly ever undertaken in a short term during the entire history of the iron and steel industry.

The output of the new and improved blast furnaces will be used largely in the manufacture of steel, although additional pig iron also will be available for foundries.

The five large new furnaces brought into operation by October, 1952, added about 2,300,000 tons of annual blast-furnace capacity to the national total and raised that total to about 76 million tons a year. The two additional furnaces will have a combined capacity of about 870,000 net tons.

The 11 furnaces scheduled for completion in the first half of this year will have a combined annual capacity of around 4 million tons of pig iron. However, three or four of these furnaces will replace older units.

Indications are that the total blast-furnace capacity increase achieved in 1952 by the programs of construction and improvement may be about 4 million tons. In 1942 and 1943, during the expansion in World War II, annual increases of around 3.5 million tons were achieved each year.

Most of the new multimillion-dollar furnaces will produce 1500 tons of pig iron a day, or ten times the daily output of a blast furnace in 1880. In a year, one of these units will be able to make more iron than was produced by over 800 furnaces in 1840.

Much additional construction work has been required at some of the new blast-furnace plants. For example, one plant being erected on a 300-acre tract includes a powerhouse, coke ovens, by-products plant, ore bridge, car dumper, railroad tracks, and much other equipment in addition to the blast furnace with its stoves, blower, and other appurtenances.

This furnace, which will make 1500 tons of iron daily, will consume two tons of iron ore, the equivalent of more than one ton of coal and 4½ tons of air a minute, as well as limestone and scrap. It also will require 121 tons of water a minute. The water will be recirculated through a cooling tower and re-used. The coke plant will produce about 1300 tons of coke and about 14 million cu ft of gas a day.

The cost of a single blast furnace with three stoves and gas-cleaning equipment is around $9 million to $11 million depending on furnace size, says a furnace-building firm.

ASME TECHNICAL DIGEST

Substance in Brief of Papers Presented at ASME Meetings

Furnace Performance Factors

Furnace Heat Absorption in a Spreader-Stoker-Fired Steam Generator, Part I—Furnace-Heat-Absorption Efficiency as Shown by Enthalpy of Gases Leaving the Furnace, by J. W. Myers and R. C. Corey, Mem. ASME, U. S. Bureau of Mines, Pittsburgh, Pa. 1952 ASME Annual Meeting paper No. 52—A-143 (mimeographed).

THIS paper is part of the fifth of a series of reports on investigations of heat absorption and distribution of heat transfer in large steam-boiler furnaces, sponsored by the ASME Special Research Committee on Furnace Performance Factors. The furnace-heat-absorption was determined from the temperature and composition of the furnace exit gases in 15 tests on a steam generator rated at 165,000 lb per hr of steam at 915 psig and 740 F at the superheater outlet, and which is fired by a spreader stoker on a front-discharge traveling grate.

The effect on furnace-heat-absorption efficiency is shown for variation of (*a*) the heat available in the furnace, (*b*) the excess air, (*c*) the percentage of combustion air admitted over the fuel bed, and (*d*) the condition of the furnace walls with respect to ash deposits. Detailed data on the distribution of gas temperature and of excess air in the furnace are presented.

The experimental values for the furnace-heat-absorption efficiency did not compare favorably with values calculated by either the Stefan-Boltzmann or the Wohlenberg equations. There is evidence, however, that the performance of a spreader-stoker-fired furnace might be predicted by the Wohlenberg equation if it were modified to allow for heat transfer resulting from a combination of suspension and fixed-bed burning.

Inasmuch as difficulty was experienced in correlating furnace performance with operating conditions, it was concluded that more extensive investigations would be required to evaluate fully the effect of all the possible variables on the performance of spreader-stoker-fired furnaces. These variables are greater in number than for other methods of firing and include, among the more important items, grate speed, speed and trajectory adjustments of feeders, depth of fuel bed, distribution of coal on the grate, distribution of underfire and overfire air, arrangement and dimensions of the overfire-air jets, temperature of the overfire air, and the method of reinjecting cinders.

It was further concluded that predicting the performance of a spreader-stoker-fired furnace by empirical methods is complicated by difficulties in analyzing the heat-transfer process for a combination of suspension and fixed-bed burning which is peculiar to this method of firing.

Heat Transfer

Protection of Heat-Exchanger Channels and Covers From Corrosion by Salt Water, by Wilfred J. Danziger and Olaf A. Sundholm, The M. W. Kellogg Company, New York, N. Y. 1952 ASME Annual Meeting paper No. 52—A-145 (mimeographed).

IN the usual shell-and-tube heat exchanger used as a cooler or condenser with fresh water as coolant, the channel, the channel cover, and the floating head cover are made of steel or cast iron.

When salt water is used as a coolant, the normal corrosion of steel and cast iron by salt water is accentuated by the galvanic cell set up by the combination of nonferrous tubes and tube sheets with the ferrous materials under discussion, and rapid failure of the ferrous parts results. This paper describes some of the materials and methods used in petroleum refineries to obtain reasonable life for channels, channel covers, and floating heads when using salt water, together with information on performance, where obtainable.

As there is wide variation in the composition of waters used for cooling purposes, and even for plants in one general locality, there may well be a significant difference in corrosion potential, depending upon where the water inlet is placed and other factors involved. Therefore selection of corrosion-resistant materials for any plant should be based on experience at that plant. For a new plant, initial selection of materials can be based on good practice in the locality. Operating experience will determine whether

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An Evaluation of the Properties of Weld Metal for Fabricating Heat Exchangers and Vessels for Low-Temperature Service, by Robert W. Bennett, American Locomotive Company, Dunkirk, N. Y. 1952 ASME Annual Meeting paper No. **52—A-146** (mimeographed).

THIS paper discusses the properties of various weld metals and base materials used in the fabrication of pressure vessels and heat exchangers for low-temperature service. To meet these service requirements, plain carbon and low-alloy steels purchased to ASTM (or ASME) or customer specifications, requiring restricted chemical analyses and mechanical properties, are generally used, the paper states. It is also essential, according to the paper, that the proper AWS class and brand of electrodes be used to obtain suitable room-temperature mechanical properties, as well as the required low-temperature toughness evaluated by the Charpy notched-bar test.

An investigation of nine brands of AWS Class E-8016 electrodes and two brands of E-7020 electrodes was conducted to determine their suitability for the fabrication of vessels and exchangers to meet the requirements set forth by Par. U-68 and U-142 of the ASME Code for Unfired Pressure Vessels for service at —150 F. Three brands of E-8016 electrodes showed consistent evidence of depositing weld metal capable of meeting all of the room-temperature mechanical and low-temperature properties, as well as satisfactory soundness and good operating characteristics. Weld metal deposited by E-7020 electrodes was definitely not suitable for —150 F service, the paper states.

Transition temperature curves of the Charpy notched-bar test data of various types of weld metals have indicated that E-6020 and E-7020 electrodes will meet all ASME Code requirements for welding killed carbon steels for service to —50 F. For service to —150 F, certain brands of E-8016 electrodes have been suitable for welding low-alloy carbon steels containing $3\frac{1}{2}$ per cent nickel or the chromium-copper-nickel steels.

Correlation of the metallurgical structure of weld metal with Charpy notched toughness indicated that a welding technique producing fine-grain weld metal is essential for optimum notched toughness. Coarse-grain dendritic weld metal generally has lower notched toughness, regardless of its chemical composition.

In considering the notched toughness of the heat-affected zone to meet Code requirements, it has been pretty well established that if the base materials are uniform and show good notched toughness at a specific temperature level, the Charpy notched-bar tests of the heat-affected zone are also generally satisfactory.

Tests on Fabricated Spherically Dished Floating Cover for Heat Exchanger, by Gunnar Sunde and Olaf A. Sundholm, The M. W. Kellogg Company, New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-147** (mimeographed).

RESULTS of a test performed to compare the relative strength of spherically dished bolted floating tube-sheet covers, as used in heat exchangers, under internally or externally applied hydrostatic pressures are reported in this paper.

A test was conducted in which two covers fabricated from stock material were bolted together, and the space between was filled with water to which a hydrostatic pressure was applied. Unfortunately, the thickness of the spherical segments was greater than specified and the flanged joint could not be kept sufficiently tight to develop a test pressure high enough to cause failure.

The test indicated that while the head under internal pressure acted in a somewhat superior manner, both heads successfully withstood a pressure equal to 3.5 times the 1950 ASME Unfired Pressure Vessel Code allowable value for a spherically dished bolted head exposed to pressure from the concave side based on actual rather than minimum specified thickness. While it would have been of interest to carry the test further and establish the pressure at which actual failure occurred, the paper states, it was felt that the pressure level reached at the initiation of local yielding was sufficiently high to justify use of the Code formulas in Par. UA-6(*b*) for pressure on either side of the head, provided that on very thin heads an additional check is made to guard against possible elastic instability of the spherical portion.

Heat-Exchanger Forgings for Low-Temperature Service, by Henry G. Holtz, Taylor Forge & Pipe Works, Chicago, Ill., and Frank S. G. Williams, Mem. ASME, Taylor Forge & Pipe Works, New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-148** (mimeographed).

MANY modern petroleum and chemical processes require heat-exchange equipment for operation at temperatures lower than —20 F, and in many cases the equipment must operate in a safe and satisfactory manner at temperatures as low as —320 F. This paper discusses ferritic-steel forgings for this class of service.

Heat-exchanger forgings for low-temperature service (up to —150 F) are generally produced from three types of ferritic steels; the thoroughly killed plain-carbon steel, the $3\frac{1}{2}$ per cent nickel steel, and the chromium-copper-nickel steel. The properties of these steel forgings at low temperature are affected by numerous factors, such as chemical composition, steelmaking practice, forging practice, heat-treatment, design of forging dies, and design of forgings. Methods used for evaluating steels for low-temperature service and procedures employed in production of these forgings are discussed in detail.

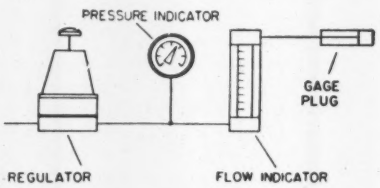
According to this paper the answer to proper forgings for low-temperature heat-exchanger equipment lies basically in steelmaking practice and in forging practices. Careful attention and control in the design of the forgings from the standpoint of mechanical strength and manufacturing operation are necessary to produce adequate forgings, the paper concludes.

Production Engineering

Introduction to Principles of Pneumatic Gaging, by David B. Kirk, Moore Products Company, Philadelphia, Pa. 1952 ASME Annual Meeting paper No. **52—A-113** (mimeographed).

PNEUMATIC gaging is a means for measuring dimensions by the use of air. In a pneumatic gage, the proximity of a surface is measured by a jet of air directed toward it by a nozzle which never touches it.

This paper explains the application of an air jet to the measurement of dimensions using the familiar laws governing flow through an orifice. It then shows how air jets can be incorporated into various types of gaging fixtures to solve a number of unusual, as well as some common, gaging problems. The paper



BASIC FLOW-TYPE PNEUMATIC GAGE

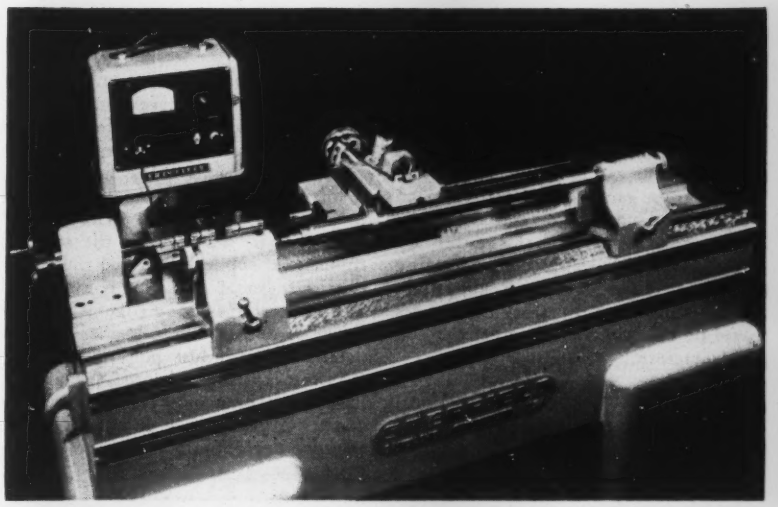
compares features of pneumatic gages with those of other conventional measuring gages and describes some of the requirements associated with the use of pneumatic gages.

Early pneumatic dimension gages, the paper states, operated at very low pressures and were sluggish and easily affected by dirt on the surface being measured. The change to higher operating pressures was not possible until suitable auxiliary regulating and indicating equipment was available. Improvements in this field, the paper states, have changed the pneumatic gage from a scientific curiosity to a practical manufacturing tool with many points of superiority over competing types of gages.

Electronic Dimensional Gaging, by Charles W. Williams, Graham-Mintel Instrument Co., Cleveland, Ohio. 1952 ASME Annual Meeting paper No. **52—A-98** (mimeographed).

THIS paper discusses dimensional-gaging devices where displacement of a measuring tip which engages the piece to be measured is magnified by a vacuum tube or similar amplifier sufficiently to permit the user to read such displacement on a scale, or to furnish the impulse to control automatic gaging and handling equipment. Use of recorders driven by the amplifier where permanent records of the measurement are useful is also discussed. These devices are very sensitive, being able to measure reliably and repeatedly variations in the workpiece as small as a millionth of an inch.

The science of electronics is a relative newcomer to gaging and quality control and makes possible certain techniques not heretofore possible, in addition to improving certain well-established gaging practices.



LEAD CHECK MACHINE WITH ELECTRONIC GAGING HEAD

Rubber and Plastics

Effect of Defects on Strength of Aircraft-Type Sandwich Panels, by A. A. Mohaupt and B. G. Heebink, U. S. Department of Agriculture, Madison, Wis. 1952 ASME Annual Meeting paper No. **52—A-99** (mimeographed).

A STUDY conducted to determine the effect of several specific types of defects on the strength properties of a limited number of typical aircraft sandwich constructions is discussed in this paper.

The paper reveals that poor bonds in sandwich constructions of aluminum facings on balsa core and of glass-cloth facings on balsa core reduced the flatwise tensile strength considerably more than they reduced the bending and edgewise compressive strengths. Unbonded areas from 1 to 3 in. in diam caused substantial reductions in the edgewise compressive strength of specimens 6 in. wide.

Wrinkles in the glass-cloth facings of specimens having balsa or glass-cloth honeycomb cores reduced the bending, edgewise compressive, and longitudinal tensile values by amounts in proportion to the depth of the wrinkles. No appreciable effect was produced on the bending and longitudinal tensile strengths by increasing the number of plies in the facings of similar specimens gradually or abruptly from 5 to 10. Butt joints in glass-cloth facings resulted in no effect on the edgewise compressive strength, but reductions were evident on the bending and longitudinal tensile strengths. A fold in the glass-cloth facing caused considerable reductions in bending, edgewise compression, and longitudinal tension.

Some Design Considerations for Injection-Molding Heating Chambers, by G. D. Gilmore and G. B. Thayer, The Dow Chemical Company, Midland, Mich. 1952 ASME Annual Meeting paper No. **52—A-105** (mimeographed; to be published in Trans. ASME).

GENERAL design of injection-molding heating chambers has been well established after gradual development through several years of experience. In this paper details of design directly concerned with the plastic material characteristics have been examined to a limited extent. Very little engineering design information has been available for a careful consideration of these details, according to this paper.

Heat-transfer and pressure losses in the heating chamber are interrelated and the geometry of the passages through which the plastic moves can be arranged for optimum heat-transfer rate with minimum pressure loss.

The available theoretical, experimental, and practical information concerning the behavior of plastic materials, under high pressure, in granular and fluid conditions is considered. This information

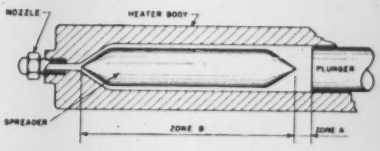


DIAGRAM OF HEATING CHAMBER

is combined into a systematic approach to the geometrical problems of the design of injection-molding heating chambers.

Stress-Crazing of Plastics, by J. A. Sauer and C. C. Hsiao, The Pennsylvania State College, State College, Pa. 1952 ASME Annual Meeting paper No. **52—A-100** (mimeographed).

EFFECT of various factors on the inception and growth of crazing is reviewed in this paper and some of the similarities between crazing in plastics, exposure-cracking in rubber, and stress-cracking in metals are described.

Various examples of stress crazing in transparent plastics are presented and the stress-strain behavior reported for crazed, noncrazed, and oriented material.

Rate of propagation of crazing was also investigated. The test results indicate that penetration of crazing cracks in polystyrene can be represented over a limited stress range by a linear function of both time and stress magnitude. Some measures advocated in this paper for avoiding the undesirable effects of crazing include use of special coatings, annealing, and establishment of working stresses based on onset of crazing rather than on static fracture.

The Effective Control of Lead Dust in the Manufacture of Vinyl Plastics, by Alexander E. Goss, Bureau of Industrial Hygiene, Connecticut State Department of Health, Hartford, Conn., and Arthur M. Ross, Jr., Ross and Roberts Company, Stratford, Conn. 1952 Annual Meeting paper No. **52—A-159** (mimeographed).

IN the manufacture of plasticized polyvinyl-chloride products, the use of powdered-lead compounds creates a definite health hazard that has been difficult to control effectively. This paper describes a new method of manufacture whereby these lead compounds, as well as other powdered stabilizers, colors, or pigments, are transferred from their original containers in an exhausted enclosure, and either processed into nondusty forms or weighed into plastic bags and sealed before entering the factory proper. The method provides the basis of maximum control of the dust hazard with a minimum of exhaust ventilation. The innovation in the manufacture of vinyl plastic products resulted in inhalation concentrations of lead in the workroom atmosphere well below the maximum allowable concentration as defined by state regulations, the paper states.

This change in the manufacturing procedure resulted in the effective control of the lead-dust hazard with a minimum of exhaust ventilation, the paper concludes.

Fuels

Pulverized-Coal Gasification Ruhrgas Processes, by Kurt Traenckner, Ruhrgas Aktiengesellschaft, Essen, Germany. 1952 ASME Annual Meeting paper No. **52—A-102** (mimeographed; to be published in Trans. ASME).

AFTER briefly reviewing the situation of Germany's gas demand and supply which makes it highly desirable to set free larger amounts of coke-oven gas by firing coke ovens with producer gas, this paper explains the general program of research and development of the Ruhrgas A.-G.

Main efforts, the paper reveals, were directed toward the development of two gas producers using low-grade pulverized coal or coal dust obtained from the coal-cleaning operations. The first process, involving gasification of pulverized coal in a vortex-type system, with slagged ash removal, has reached the state of commercial applicability, and the results obtained exceed those of conventional gas producers gasifying coke.

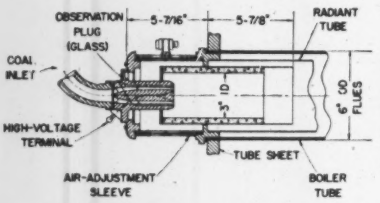
The second process described in some detail—the coal-dust pulsejet gasifier—is in the experimental stage, but already has shown promising results the paper states. Further work is in progress to improve operations and efficiencies.

The Combustion of Pulverized Coal in a Water-Cooled Radiant Tube, by Ralph A. Sherman, Fellow ASME, and Gerald E. Keinath, Jun. ASME, Battelle Memorial Institute, Columbus, Ohio, and R. Tom Sawyer, Mem. ASME, American Locomotive Company, New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-123** (mimeographed).

A SERIES of trials of the combustion of pulverized coal in alloy-steel tubes from which the heat was absorbed by an outer, annularly spaced, water-cooled tube are described in this paper. Only one diameter of alloy tube, 5 in., in lengths of 10, 15, and 20 ft, was used for the trials. A high-volatile coal, pulverized to a fineness of 90 per cent through a 200 mesh screen, was fired to this tube at rates of 40 to 160 lb per hr.

For the arrangement used, the fraction of the heat input in the coal that was absorbed by the water in the outer tube was only 20 to 40 per cent. Thus the particular arrangement used was practical for a boiler. The interest in the tests lies in the fact that a coal whose ash-softening and fluid temperatures were 2160 and 2220 F, respectively, was burned at extremely high rates of heat liberation without difficulty from slagging.

It appears possible that a tube of somewhat larger diameter would give a wall temperature high enough to have a satisfactorily low loss in unburned carbon and yet not so high as to result in difficulty from slag formation. The possibility of the application of this principle to the steam-locomotive boiler prompted the research described. A design of a locomotive incorporating these tubes is presented in the paper.



SUGGESTED DESIGN OF BURNER FOR LOCOMOTIVE

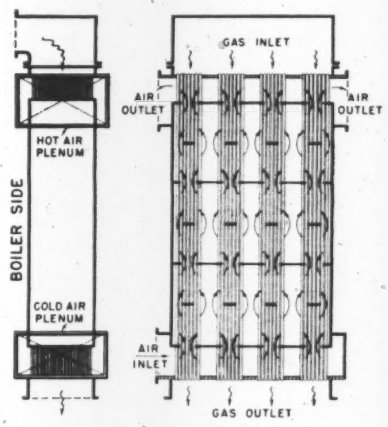
The data presented on a somewhat unusual method of combustion of pulverized coal show that, in the size of the tube used, the efficiency of combustion was lower than would be acceptable for the application of the principle to steam generators. However, the tests did show that the principle was operable and that slagging was definitely avoided at quite high rates of heat liberation.

Tubular Air-Heater Problems, by E. F. Rothemich, Jun. ASME, and G. Parmakian, Mem. ASME, Riley Stoker Corporation, Worcester, Mass. 1952 ASME Annual Meeting paper No. **52—A-124** (mimeographed).

OCCURRENCE of air-heater deposits, their effect on performance, maintenance, and design are covered in this paper. Actual operating experiences and a survey of a large number of installed tubular air heaters are given to show the extent of the air-heater problems being encountered by steam-generating units fired with pulverized coal, stoker, natural gas, as well as those fired with oil. Suggestions are offered as to methods for minimizing these difficulties by design and operation.

According to the paper, plugging and corrosion of tubular air heaters is widespread in every section of the country with all types of fuels and air-heater arrangements. To minimize corrosion the initial design of the unit should include some method for raising tube-metal temperature such as air by-passing, air recirculation, or other means. The operator should determine the safe tube-metal temperature for his particular installation by attaching thermocouples on the air-heater tubes and collecting temperature data during the normal operation. Once this minimum safe tube-metal temperature has been established for his particular unit the operator can maintain the coldest tube above this temperature by the method provided by the designer.

It is possible to clean air heaters in service and more attention should be given to this phase of operation and design to maintain clean air-heater tubes, the paper states. Once plugging has occurred it is possible to remove the deposits by the use of hot water, since these deposits are mostly water-soluble. When high-sulphur fuels are to be fired



TYPICAL TUBULAR AIR-HEATER DESIGN

the designer should attempt to provide for water-washing of the air heater in the initial design.

Provisions should also be made in design for the repair of corroded sections of the air-heater tubes, either by the use of short tube lengths and ferrules or by the use of two-section air heater if appreciable corrosion is anticipated.

If proper consideration is given to the design and operation of tubular air heaters, the result would be a relatively low-cost heat-recovery apparatus which is effective, economical, and has excellent availability, the paper concludes.

Air-Preheater Design as Affected by Fuel Characteristics, by Hilmer Karlsson, Fellow ASME, and William E. Hammond, The Air Preheater Corporation, Wellsville, N. Y. 1952 ASME Annual Meeting paper No. **52—A-125** (mimeographed; to be published in Trans. ASME).

THE fuel characteristic that appears to control the plugging and corrosion in air heaters is the sulphur content, according to this paper. While other fuel constituents contribute to the degree of the problem, their effectiveness depends upon the sulphur content. The presence of carbon in the fuel gas may aggravate the corrosion problem so that the best combustion conditions must be carefully maintained.

In selecting air heaters for new installations, it is not possible to predict with any certainty the type of fuel that will be available during the life of the application; consequently the air-heater design must provide controls that will maintain the cold-end temperatures within safe limits.

This paper recommends the use of Cor-Ten or Mayari-R for the low-temperature surface and the use of cold-end baskets.

Application of effective soot blowers using superheated steam or dry compressed air permits control of deposit formation. In the event that circumstances result in serious deposit formation, provision for water-washing of the heaters will provide an effective remedy.

Handling Coal and Ashes Economically in the Smaller Plants, by D. M. Given, Jun. ASME, and C. A. Marshall, Mem. ASME, Fairmont Coal Bureau, New York, N. Y. 1952 ASME-AIME Joint Fuels Conference paper No. **52—FU-2** (mimeographed).

THIS paper is intended to give some guidance in the selection of coal and ash-handling equipment for boiler plants burning less than 30,000 tons of coal annually. Specific types of systems are discussed as having economic application to the different plant sizes. Economic analysis shows that the total of fixed charges and operating costs for handling both coal and ashes can easily be controlled to less than $1 per ton of coal consumption.

Maintenance requirements, stationary coal-handling systems, coal weighing, coal storage piles, ash handling, and a silo system for 15,000-ton per year plants are among the subjects covered in the paper.

Standardization, according to the paper, has many advantages and might well be incorporated into equipment specifications, keeping in mind that the actual arrangement of equipment may be varied in the individual plant according to the space conditions.

Opportunities for standardizations have received very little attention in the past, the paper states. Many plants have only one-day coal bunkers, while others have bunker capacity for as much as six weeks' supply of coal. Unnecessary extras in one part of a system and inadequate design in another part characterize a great many installations. Improved engineering standards and more careful co-ordination with actual handling requirements will do much to provide economical and convenient coal handling.

Cyclone Dust Collectors for Boilers, by A. J. ter Linden, Delft University, Delft, Holland. 1952 ASME-AIME Joint Fuels Conference paper No. **52—FU-1** (mimeographed).

THE inconvenience caused in the neighborhood of a boiler plant depends on the quantity of the gases and dust particles leaving the stacks, the size of these particles, the height of the stacks, the nature of the surroundings, and other factors.

It may be possible to construct installations capable of protecting the surroundings of the boilerhouse from all nuisances. However, these installations are so expensive that seldom is it justified to put them into practice. Therefore a compromise must be made between the hygienic and the economic demands and a solution found which will obtain a reasonable protection of the environment of the boilerhouse at a reasonable cost.

The following systems of dust collectors are recommended:

1 For small grate-fired boilers with a maximum capacity of about 30 ton per hr, one or two complete cyclones in parallel. The exhaust should not exceed 5 ft.

2 For larger grate-fired boilers, a highly efficient multicyclone. To prevent the blocking up of the small passages the exhaust diameter of the cyclones should not be less than 5 in.

3 For pulverized-fuel boilers in an industrial or rural district, a highly efficient multicyclone or a multicyclone of simple design in combination with an electrostatic precipitator.

4 For pulverized-fuel boilers in a residential district, a multicyclone in combination with a highly efficient electrostatic precipitator.

In all these cases a high stack is necessary in order to avoid nuisances to the surroundings.

Process Industries

Turboexpanders for Low-Temperature Refrigeration, by A. M. G. Moody, Mem. ASME, Trane Company, La Crosse, Wis., and L. C. Claitor, Elliott Company, Jeannette, Pa. 1952 ASME Annual Meeting paper No. **52—A-114** (mimeographed).

IN recent years the radial-inflow turbine has been employed in a number of applications where its particular characteristics offered definite advantages. Among applications in which it offers an advantage over other types is refrigeration to temperatures between 0 F and —300 F. According to this paper, there is an optimum range of specific speed where the turboexpander is superior to reciprocating and axial-flow types. This paper discusses a number of mechanical and process considerations, including materials.

While stainless steels are recognized as

being suitable, cheaper materials may be satisfactory, the paper states. The sealing problem is influenced by the value of the medium handled. Thermal contraction during start up dictates large clearances, favoring a shrouded wheel. Mounting of the casing must maintain alignment during thermal changes. Several types of brake can be employed, including induction generator, blower, and pump, the paper reveals. Control by inlet throttle valve is preferred to partial admission or adjustable nozzle. Erosion presents a serious problem. Acceptable enthalpy drop per stage is 30 Btu per lb. Higher values require special designs.

In general, the paper concludes, the radial turbine should not be considered for more than one stage. If multistaging is necessary, an axial-flow turbine should be given careful consideration, since it will probably have equal or better performance and be less expensive to build. There may be infrequent applications where specific speed or flow considerations will still necessitate a multistage turboexpander.

Metals Engineering

On the Validity of Assumptions Made in Theories of Plastic Flow for Metals, by Joseph Marin, Mem. ASME, and L. W. Hu, The Pennsylvania State College, State College, Pa. 1952 ASME Annual Meeting paper No. **52—A-80** (mimeographed; to be published in Trans. ASME).

RESULTS of a series of special biaxial stress tests made to check the validity of certain assumptions used in theory of plasticity are reported in this paper. In these tests the stresses produced were tensile biaxial stresses introduced in a tubular specimen by applying an internal pressure and axial tension. The stresses produced were in the plastic range and the material tested was a hot-rolled aluminum alloy designated as 14S-T6. A test to determine the validity of the distortion-energy criterion used in formulating the plastic stress-strain relations by the flow theory, showed that the test results did not support this assumption.

Special tests were also made to determine whether plastic-deformation requirements as predicted by the slip theory were correct. These tests showed that in so far as these tests were concerned, the results supported the slip theory.

Finally, tests were made to check the assumption of constancy of volume and constancy of incremental change in volume as required by the deformation and flow theories. These test results do not support the assumptions made in these theories relative to volume change, the paper concludes.

Effect of Stress Amplitude on Statistical Variability in Fatigue Life of 75S-T6 Aluminum Alloy, by G. M. Sinclair and Thomas J. Dolan, Mem. ASME, University of Illinois, Urbana, Ill. 1952 ASME Annual Meeting paper No. **52—A-82** (mimeographed; to be published in Trans. ASME).

RECENT studies indicate that most of the "scatter" observed in finite fatigue-life testing of metals is an inherent characteristic of the material and does not necessarily indicate poorly adjusted machines or improper testing techniques. In the present study, groups of 17 to 57 specimens of 75S-T6 aluminum alloy were tested in rotating bending at six different stress levels. The smallest stress used was 30,000 psi and the greatest was 62,500 psi. A statistical analysis was made of fatigue-life data obtained at each of the six stresses.

Constants of an *S-N* relation, recently proposed by W. Weibull, were evaluated for a probability of failure $P = 0.50$. Results of the study are summarized in two equations and in a composite *S-N* diagram showing lines of equal probability of failure.

It was concluded that the distribution of fatigue life N for a given stress is approximately logarithmic normal, although it is believed that the logarithmic-normal relationship is increasingly in error for probabilities of failure smaller than 1 per cent.

The standard deviation (which is a measure of scatter in the fatigue life) is determined primarily by the applied stress. A relationship may be represented by a simple exponential function within the stress range investigated. In general, this variability in fatigue life decreases when the stress amplitude is increased. The extra work involved in making a statistical approach to fatigue problems appears to be justified by the additional information obtained.

The Importance of Carbon in Ferrous Metals for Engineers, by Harry K. Ihrig and John T. Jarman, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. 1952 ASME Annual Meeting paper No. **52—A-81** (mimeographed).

THE role of carbon as an alloying element in iron and steel is often overlooked, according to this paper. It is the most essential element used and the total tonnage of carbon steel exceeds that of all other alloy steels, the paper states.

Principal properties of ferrous metals are largely the result of the amount and type of carbon alloyed with the iron. This paper describes experimental work starting with a base iron to which carbon and other alloying elements are added. Engineering properties of the various steels produced are compared and related to their alloy content. Carburization and decarburization are also discussed. Detrimental effects of carbon in both straight carbon and stainless steels are pointed out.

Effect of both the amount and the form of carbon in cast irons is shown experimentally in this paper. The role of carbon in the production of the nodular cast irons, which are new engineering materials with unique properties, is also shown.

In conclusion, the paper states that carbon increases the strength and hardness in steels, particularly after heat-treatment. The ultimate possible strength and hardness is largely determined by the amount of carbon present. Tensile strengths of 50,000–350,000 psi can be obtained in steels with a carbon variation of less than 1 per cent. No other alloying element gives results comparable to carbon in such small amounts.

In cast irons the type of carbon largely determines the properties of the metal. Nodular iron with its carbon in spherular form has the best properties of any of the cast irons.

The important role of carbon in ferrous metals should be considered when designing machines or structures.

Metals Joining in the Transformer Industry, by Lawrence D. Jennings, Mem. ASME, Westinghouse Electric Corporation, Sharon, Pa. 1952 ASME Annual Meeting paper No. **52—A-83** (mimeographed).

METALS joining is important to the transformer industry to make the electrical and mechanical joints essential to the fabrication and operation of a modern transformer. This paper discusses several processes of metals joining including the following: Manual and automatic welding, gas welding, resistance welding, soldering, brazing, and bolting. The paper covers different applications of these processes and discusses some advantages and disadvantages of each.

In joining metals, according to this paper, a great amount of engineering design and development is required. The joining must be positive, yet economical. The resulting joints must withstand shipping and handling stresses, usually must be pressure-tight, must be corrosion-resistant, and must be permanent.

Applied Mechanics

Natural Frequencies of Twisted Cantilever Beams, by D. D. Rosard, Jun. ASME, Westinghouse Electric Corporation, Lester, Pa. 1952 ASME Annual Meeting paper No. **52—A-15** (in type; to be published in the *Journal of Applied Mechanics*).

WHEN a cantilever beam, an aircraft propeller, a turbine or compressor blade, is twisted, the natural frequencies of vibration may be changed appreciably. The effect of twist depends on the width-to-thickness ratio. An experimental and analytical investigation was made of the effect of twist for various width-to-thickness ratios.

Deflections of Circular Beams Resting on Elastic Foundations Obtained by Methods of Harmonic Analysis, by Enrico Volterra, Mem. ASME, Rensselaer Polytechnic Institute, Troy, N. Y. 1952 ASME Annual Meeting paper No. **52—A-16** (in type; to be published in the *Journal of Applied Mechanics*).

SOLUTIONS in form of Fourier series are given for the problem of circular beams resting on elastic foundations on the assumption that the foundation reacts according to the classical Winkler-Zimmermann hypothesis. The case of an arbitrary load distribution is disposed of by separate treatment of the symmetric and antisymmetric load components. Numerical tables of the coefficients of the trigonometric series expressing deflections, angles of twist, bending and twisting moments are presented for both symmetric and antisymmetric loadings.

Pure Bending of an Incomplete Torus, by M. A. Sadowsky, Mem. ASME, and E. Sternberg, Jun. ASME, Illinois Institute of Technology, Chicago, Ill. 1952 ASME Annual Meeting paper No. **52—A-17** (in type; to be published in the *Journal of Applied Mechanics*).

AN exact solution in series form is presented for the stresses and displacements in an incomplete torus of circular center line and circular cross section under conditions of pure bending. The solution is preceded by a formal treatment of the case in which the shape of the cross section is arbitrary. This more general problem is reduced to one of axisymmetry, which is in turn attacked by a modification of the stress-function approach of Timpe to rotationally symmetric problems in elasticity theory. The modified stress-function approach, which may be of interest beyond the present application, is referred to general orthogonal axisymmetric co-ordinates, and the solution of the specific problem considered here is based on the use of toroidal co-ordinates. The normal stresses acting on the circular cross sections of the torus are evaluated numerically in an illustrative example and are compared with the results of previous approximate solutions of the same problem. The adaptation of the present solution to the determination of the initial stresses in a complete torus from which a wedge-shaped portion has been removed is indicated.

An Invariant Membrane Stress Function for Shells, by H. L. Langhaar, Mem. ASME, University of Illinois, Urbana, Ill. 1952 ASME Annual Meeting paper No. **52—A-18** (in type; to be published in the *Journal of Applied Mechanics*).

INEXTENSIONAL shells that have no thickness are idealized representations of real shells that have small bending stresses and small deformations. With certain restrictions, the stresses in these shells are derivable from a generalized Airy function. For shells of constant Gaussian curvature, the stress function is unrestricted, but, for other shells, it is expressed as a function of the Gaussian curvature. Although, in this respect, it is less general than Pucher's stress function, it has the advantage that it may be used with any surface co-ordinates.

Response of an Elastic Cylindrical Shell to a Transverse, Step Shock Wave, by R. D. Mindlin, Mem. ASME, and H. H. Bleich, Columbia University, New York, N. Y. 1952 ASME Annual Meeting paper No. **52—A-19** (in type; to be published in the *Journal of Applied Mechanics*).

IN this paper there is described a mathematical study of the response of a cylindrical shell to a shock wave. The shell is elastic, circular in cross section, homogeneous, and infinitely long. Its motions are restricted to dilatational, translational, and inextensional-flexural modes. The shell is submerged in an acoustic fluid, i.e., one whose motions conform to the linear theory of waves of expansion. The shock wave is assumed to be plane, with its wave front parallel to the axis of the shell.

By means of an approximation, which is valid for the early stages, the potential of the diffraction and radiation is eliminated between the simultaneous equations which couple the generalized co-ordinates of the shell and the fluid. As a result, a simple differential equation is obtained for each generalized co-ordinate describing the motion of the shell. The solution is reduced to a definite integral during the time of transit of the shock-wave front across the shell and, for the case of the step shock wave, is expressed in terms of tabulated functions thereafter. Explicit formulas are given for the displacement, velocity, acceleration, and pressure associated with each mode of motion of the shell.

On an Iterative Method for Nonlinear Vibrations, by R. E. Roberson, Jun. ASME, North American Aviation, Downey, Calif. 1952 ASME Annual Meeting paper No. **52—A-20** (in type; to be published in the *Journal of Applied Mechanics*).

AN iterative method for nonlinear vibrations, previously discussed by Brock, is treated from a primarily analytic point of view. In this light, it is a modification of a Picard-like process for two-point boundary conditions mentioned by Gwoh-Fan Djang. It is generalized from previous treatments to systems with more than one degree of freedom and to dissipative systems. Despite its quite different rationale, the results are only slight modifications of those obtained by the application of Duffing's method, indicating that the two are facets of the same fundamental process.

The Origin of Damping in High-Strength Ferromagnetic Alloys, by A. W. Cochardt, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1952 ASME Annual Meeting paper No. **52—A-21** (in type; to be published in the *Journal of Applied Mechanics*).

A THEORETICAL analysis and test data are presented which explain the damping capacity of standard high-strength alloys in terms of the magnetostrictive effect. Conditions for obtaining maximum damping are described and the results of experiments are reported which provide a firm basis for the development of high-strength high-damping alloys.

On the Plastic Strains in Slabs With Cutouts, by P. G. Hodge, Jr., Jun. ASME, University of California, Los Angeles, Calif. 1952 ASME Annual Meeting paper No. **52—A-22** (in type; to be published in the *Journal of Applied Mechanics*).

THE complete elastic-plastic problem is set up for a circular slab with a central circular cutout, subjected to uniform external tension. The analysis is carried out under the assumption of generalized plane stress but with possibly finite deformations. The material is assumed to be isotropic, homogeneous, and incompressible, to yield according to the Tresca

yield condition, and to satisfy Hooke's law in the elastic domain and the plastic potential law in the plastic domain. The equations are solved by a perturbation method based on the ratio of the maximum shear stress to the shear modulus, in which each of the significant quantities, stress, displacement, and slab thickness, is expanded in a power series in this ratio. A similar technique is employed to solve the fully plastic flow problem. It is shown that for cutout radii greater than 1 per cent of the radius of the slab, the "first approximations" obtained by neglecting all but the leading term in each series are satisfactory, up to loads at which the slab becomes wholly plastic. The ratio of the maximum strain in the just fully plastic slab to that in the completely elastic slab is computed. It is found that this ratio is less than about 6 if the cutout radius is at least 1 per cent of the radius of the slab. Some observations are advanced on the case where the cutout is very small compared to the slab.

Forced Lateral Vibration of Beams on Damped Flexible End Supports, by D. F. Miller, Jun. ASME, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1952 ASME Annual Meeting paper No. **52—A-23** (in type; to be published in the *Journal of Applied Mechanics*).

THE steady-state forced-vibration problem, for a beam or rotating shaft on damped flexible end supports, is completely solved by the procedure described. The analysis is an extension of a Holzer-type iteration method applied to beams by Myklestad and others. Resonant frequencies of any mode, forced amplitudes, shears, and moments at any point on the beam, and phase effects introduced by the damping, are all evaluated. The damped problem is handled conveniently using complex notation with its vector interpretation. Vector diagrams, which give a physical idea of the vibration, are shown for the two numerical examples of the paper.

Influence Coefficients of Tapered Cantilever Beams Computed on SEAC, by Samuel Levy, Mem. ASME, National Bureau of Standards, Washington, D. C. 1952 ASME Annual Meeting paper No. **52—A-25** (in type; to be published in the *Journal of Applied Mechanics*).

A DESCRIPTION is given of a method for computing the influence coefficients in bending of a nonuniform cantilever beam using a basic code devised for the National Bureau of Standards electronic automatic computer SEAC. The given data for a particular problem are n, the number of stations at which influence coefficients are desired; EI_0, EI_1, . . . EI_n, the bending stiffnesses at the root and at successive stations; and l_1, l_2, . . . l_n, the distances between these stations. The basic code can be used in any case where the number of stations n is fewer than 23. In an example for a beam having 9 stations, the computing time was 3 min.

Unsteady Radial Flow of Gas Through Porous Media, by R. Jenkins and J. S. Aronofsky, Magnolia Petroleum Company, Dallas, Texas. 1952 ASME Annual Meeting paper No. **52—A-26** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper presents a numerical method for describing the transient flow of gases radially inward or outward through a porous medium in which the initial and terminal pressures and/or rates are specified. Specific examples are worked out which have application in the study of natural-gas reservoirs. The computations were carried out by means of punch-card machines. The pressure distribution as a function of time has been calculated for various ratios of reservoir diameter to well diameter and for various dimensionless-flow rates for a well penetrating the center of a homogeneous disk-shaped reservoir. A simple means of predicting the well pressure at any time in the history of such an idealized field has been developed. Flow rates and pressure distributions within the radial reservoir also have been calculated for the case in which the well pressure is suddenly lowered from its initial static value, and then held constant.

Frequencies of Longitudinal Vibration for a Slender Rod of Variable Section, by James L. Lubkin, Jun. ASME, and Yudell L. Luke, Midwest Research Institute, Kansas City, Mo. 1952 ASME Annual Meeting paper No. **52—A-27** (in type; to be published in the *Journal of Applied Mechanics*).

THE natural frequencies of a slender, homogeneous, fixed-free rod of variable section are studied in a one-dimensional theory. The rod is uniform at the fixed end for a certain distance L_1, and then tapers for a distance L_2 so that the cross-sectional area varies linearly. The frequency equation is derived and its first five zeros are tabulated for several ratios of L_1 to L_2, and various tapers. The first few terms of asymptotic expansions for the roots of the frequency equation are presented and discussed.

On the Application of the Impedance Method to Continuous Systems, by P. F. Chenea, Purdue University, Lafayette, Ind. 1952 ASME Annual Meeting paper No. **52—A-28** (in type; to be published in the *Journal of Applied Mechanics*).

IT is shown how the concept of impedance may be extended to apply to those continuous systems whose vibratory behavior leads to the wave equation. The use of the method is demonstrated by three examples which include the free and forced vibration of an elastic bar in longitudinal oscillation and torsional oscillation of a tapered shaft.

ASME Transactions for January, 1953

THE January, 1953, issue of the Transactions of the ASME (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following technical papers:

A Clearancemeter for Determining Blade-Tip Clearances of Axial-Flow Compressors, by A. W. Brunot and R. O. Fulton. (52—SA-16)

Fast Thermocouples as Control-System Elements Sensing Exhaust-Gas Temperatures in Aircraft Gas Turbines, by J. S. Alford and C. R. Heising. (52—SA-35)

A Study of Burner Oscillations of the Organ-Pipe Type, by A. A. Putnam and W. R. Dennis. (52—SA-12)

An Energy Basis for Comparison of Performance of Combustion Chambers, by J. B. Nichols. (52—SA-37)

Comparative Performance of Coals of Different Rank in a Film-Cooled Gas-Turbine Combustor, by T. E. Warren, H. P. Hudson, J. D. Robertson, and J. C. Mulligan. (52—SA-4)

A Nondimensional Correlation of Flame Propagation at Subatmospheric Pressures, by R. E. Cullen. (52—SA-39)

NACA Sonic-Flow-Orifice Temperature Probe in High-Gas-Temperature Measurement, by P. L. Blackshear, Jr. (52—SA-38)

Use of the Centrifugal Governor Mechanism as a Torsional Vibration Absorber, by O. A Pringle. (52—SA-34)

Axial Tension and Bending Interaction Curves for Members Loaded Inelastically, by D. O. Brush and O. M. Sidebottom. (52—SA-6)

Distribution of Mechanical and Thermal Stresses in Multilayer Cylinders, by R. A. Strub. (52—SA-5)

The Stresses in a Pressure Vessel With a Hemispherical Head, by G. W. Watts and H. A. Lang. (52—SA-19)

Flame Velocities in Carbon Monoxide-Oxygen Mixtures, by T. W. Price and J. H. Potter. (52—SA-65)

Operating Experiences With Mechanical Joints in High-Pressure High-Temperature Steam Piping, by E. C. Bailey, H. C. Schroeder, and I. H. Carlson.

Relative Abrasiveness of the Cast Surfaces of Various Gray-Iron Castings on Single-Point Tools of High-Speed Steel, by Joseph Datsko and O. W. Boston. (52—SA-17)

The Significance of the Thermal Number in Metal Machining, by B. T. Chao and K. J. Trigger. (52—SA-58)

REVIEWS OF BOOKS

And Notes on Books Received in the Engineering Societies Library

Fatigue and Fracture of Metals

FATIGUE AND FRACTURE OF METALS. (A symposium held at the Massachusetts Institute of Technology, June 19-22, 1950.) Edited by W. M. Murray, with a foreword by J. C Hunsaker. The Technology Press of the Massachusetts Institute of Technology and John Wiley & Sons, Inc., New York, N. Y., 1952. Cloth, 5½ × 9 in., figs., references, tables, viii and 313 pp., $6.

REVIEWED BY H. F. MOORE[1]

IN June, 1939, the Bureau of Aeronautics of the U. S. Navy Department appointed a committee to consider the writing and the publication of a book which should deal with the prevention of fatigue failures in metal parts of ships, machines, and structures. The Battelle Memorial Institute was asked by that committee to undertake the writing of such a book, and in 1941 it was published by John Wiley & Sons. The book was edited by H. W. Gillette.

In June, 1950, a committee of the Massachusetts Institute of Technology held a symposium in Cambridge, Mass., at which several hundred engineers, physicists, and metallurgists were present. The book herein reviewed presents developments and explanations of fatigue phenomena which have been observed since 1939 as well as revised explanations of phenomena previously observed.

This book contains the text and the illustrations of the 14 papers presented at this 1950 symposium, and the writer of this review thinks this book will be valuable to the students of mechanics of materials, especially to those who are concerned with fatigue and fracture of metals, and in the new problems which have become apparent since the publication of the Battelle book 11 years ago.

There is a good bit of "hard reading" in these 14 papers, and the problems which are as yet unsolved are not a few, but for any one who has to solve fatigue problems, the reading of these papers will repay a good many hours of thought. These papers are concerned not only with fatigue, but also with brittle fracture and creep fracture.

The following list of titles and authors of the 14 papers will, the reviewer believes, give some idea of the fields studied since 1941 and will give readers of the review an idea of the value of new ideas and methods:

1 "General Survey of the Problem of Fatigue and Fracture," by M. Gensamer, professor of metallurgy, Columbia University, New York, N. Y.

2 "The Fatigue Problem in Airplane Structures," by H. L. Dryden, R. V. Rhode, and P. Kuhn, National Advisory Committee for Aeronautics, Washington, D. C.

3 "Brittle Fracture and Fatigue in Ships," by Finn Jonassen, technical director, Committee on Ship Steel, National Research Council, Washington, D. C.

4 "Brittle Fracture and Fatigue in Machinery," by R. E. Peterson, Westinghouse Research Laboratories, East Pittsburgh, Pa.

5 "Internal Stress and Fatigue," by O. J. Horger, chief engineer, Railway Division, and H. R. Neifert, research engineer, Timken Roller Bearing Company, Canton, Ohio.

6 "Designing for Fatigue," by R. L. Templin, chief engineer of tests, Aluminum Research Laboratories, New Kensington, Pa.

7 "Fundamentals of Brittle Behavior in Metals," by Egon Orowan, professor of mechanical engineering, Massachusetts Institute of Technology, Cambridge, Mass.

8 "Experimental Study on Temper Brittleness of Slightly Alloyed Carbon Steel," by Pierre A. Jacquet and Adrienne R. Weill, Ingénieurs Contractuels des Constructions et Armes Navales, Paris, France.

9 "The Statistical Aspect of Fatigue Failures and Its Consequences," by W. Weibull, professor, Royal Institute of Technology, Stockholm, Sweden.

10 "A Review of Cumulative Damage in Fatigue," by N. M. Newmark, research professor of structural engineering, University of Illinois, Urbana, Ill.

11 "Significance of Transition Temperature in Fatigue," by C. W. MacGregor, vice-president in charge of engineering, University of Pennsylvania, Philadelphia, Pa.

12 "The Influence of Metallographic Structure on Fatigue," by P. L. Teed, deputy chief of aeronautical research and development, Vickers-Armstrong, Ltd., Weybridge, England.

13 "Fatigue at Elevated Temperatures," by N. J. Grant, associate professor of metallurgy, Massachusetts Institute of Technology, Cambridge, Mass.

14 "The Techniques of Physical Metallurgy for Studying Fatigue Damage," by John T. Norton, professor of physics of metals, Massachusetts Institute of Technology, Cambridge, Mass.

[1] Research professor of engineering materials, emeritus, University of Illinois, Urbana, Ill. Mem. ASME.

Aeronautics at the Mid-Century

AERONAUTICS AT THE MID-CENTURY. (The Terry Lectures.) By J. C. Hunsaker. Yale University Press, New Haven, Conn., 1952. Cloth, 5 × 8¼ in., illus., 116 pp., $3.

REVIEWED BY HUGH L. DRYDEN[2]

ONE of the problems of our generation is the assimilation and interpretation of the ever-expanding store of scientific and engineering achievement. The pace of technological development is so rapid that even the specialist has difficulty in remaining well informed. How much more difficult is the task of the interested observer who seeks to understand and evaluate the significance of technological achievements for his own welfare and the welfare of society.

One of the major technical developments of our century with a major impact on all mankind is the airplane. In the 1952 Terry lectures at Yale, a distinguished aeronautical engineer, Jerome C. Hunsaker, professor of aeronautical engineering at the Massachusetts Institute of Technology and Chairman of the National Advisory Committee for Aeronautics, reviews fifty years of aeronautical development, describes the present state of the art and trends, and makes some observations on the social

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and political effects of both civil and military aeronautics. To Professor Hunsaker is due gratitude and appreciation for this essentially conservative review of a development which so readily lends itself to sensational exposition and unbridled speculation.

"The ocean of air provides highways from anywhere to everywhere." But as Professor Hunsaker goes on to describe, the highway is not only a route for trade and interchange of visits and ideas but it can also be a path of sudden destruction. In this dual possibility, the development of the ethically neutral airplane is compared to the domestication of the horse which gave mobility to peaceful men and their goods or to Mongol warriors, and to the development of the ship which was the basis of war and pillage as well as trade and colonization. The airplane is now the foundation of military air power but it has yet to attain potential world-wide utilization in peaceful pursuits.

At the beginning of the century all the components of the airplane, including the gasoline engine, were known but it was left to Wilbur and Orville Wright to solve the riddle of airplane control and to realize the age-old dream of human flight. The rapid development of the airplane is attributed to the availability of gasoline and to the growing political instability which led many nations to devote large sums to the new military weapon. By 1948 it was estimated by Sir Richard Fairey that the total expenditures on aeronautics by all nations for all purposes added up to 256 billion dollars.

So far as the technical development of the airplane is concerned, the slow upward trend of performance has recently been subjected to the impact of jet propulsion. While the fuel economy of gas turbines leaves something to be desired, methods of improvement are already in sight. Organized research is an important element in the further development of jet propulsion; without the guidance of aerodynamic and propulsion research, supersonic flight probably would not have been achieved experimentally today. Professor Hunsaker foresees the continued application of each of the different means of propulsion, propeller and reciprocating engine, propeller-turbine, and turbojet but doubts that there will be reason to fly passengers at supersonic speeds.

Civil air transportation began in the United States in 1926 with contracts to pioneer airlines to carry mail. A significant forward step was taken with the passage of the Civil Aeronautics Act of 1938 which Professor Hunsaker characterizes as a social document of some significance. In 1951 U. S. air transportation became a billion-dollar industry. A recent innovation is air-coach service at reduced fares which has already greatly increased air travel on routes where the service is offered. The air-line safety record looks pretty good but it can be kept so or bettered only by great vigilance as new high-performance airplanes replace the current types. Airports offer many technical and economic problems. Probably like ships and their ports, there will be several types of airports with corresponding types of airplanes organized to handle a particular class of traffic. Private flying has declined chiefly because of the high cost of owning and flying an airplane. Helicopters will progress rapidly as their development for military uses is accelerated.

The final chapter of the book deals with social and political effects: After a brief review of various civil uses of airplanes, of the airspace and national sovereignty, and of the Arctic Airspace, a more extended discussion is given of air power, and its economic effects. A bipolar political world has evolved because the airplane has immensely increased the national power of the large industrialized states at the expense of the smaller ones.

Professor Hunsaker asserts the dominating influence of technology in social progress. He recalls that historians commonly emphasize the role of great men and fail to recognize the role of technology. Thus "Columbus did discover America and set in train a vast succession of social changes, but back of Columbus lay the development of the ship. Without Columbus some other European would have discovered the New World; the existence of the ship guaranteed it. There is a propelling force in technology which drives great men and also constitutes the propelling force of ideas . . . . . Our present international society is in the process of adjusting itself to the innovation of flight . . . . . and the final pattern has not yet evolved."

Library Services

ENGINEERING Societies Library books may be borrowed by mail by ASME Members for a small handling charge. The Library also prepares bibliographies, maintains search and photostat services, and can provide microfilm copies of any items in it collection. Address inquiries to Ralph H. Phelps, Director, Engineering Societies Library, 29 West 39th St., New York 18, N. Y.

Books Received in Library

ACTES DU COLLOQUE INTERNATIONAL DE MÉCANIQUE. Poitiers, 1950. Tome V: Etudes sur la Mécanique Générale. France, Ministère de l'Air, Publications Scientifiques et Techniques, No. 263, 1952. Paper, 7 × 11½ in., 263 pp., diagrams, graphs, illus., 1800 fr. Fifteen papers are given, continuing the studies in the field of "general mechanics." Seven of them deal with the determination of strains and stresses either by analytical methods or physical, such as strain gages, brittle lacquers, and so on. The remaining eight papers outline various experimental approaches to a number of problems in dynamics.

ATOMIC POWER. By Walter Isard and Vincent Whitney. The Blakiston Company, New York, N. Y., 1952. Bound, 6¼ × 9¼ in., 235 pp., tables, graphs, $4.75. Beginning with a brief résumé of the technical background, the authors continue with a factual analysis of the economic, sociological, political, and geographical aspects of atomic-power development. Part 2 deals with costs and industrial applications, utilizing the iron and steel industry and the aluminum industry as case studies. Part 3 discusses the relation of atomic power to the process of economic development and its impact upon regional economies, with Brazil particularly considered as a case study. A considerable amount of statistical data is provided as necessary basic information.

CALCUL DE LA COUCHE LIMITE COMPRESSIBLE. By Adalbert Oudart. France, Ministère de l'Air, Publications Scientifiques et Techniques, No. 258, Paris, France, 1952. Paper, 7 × 10½ in., 66 pp., tables, 550 fr. A detailed treatment of two practical methods of calculation of the boundary-layer problem in a compressible fluid. Numerical applications are included, and the analytical text is illustrated by a group of nomograms and other graphs.

CONTRIBUTION A L'ETUDE AERODYNAMIQUE DE L'AILE ET DE L'HÈLICE. By Maurice Ménard. France, Ministere de l'Air, No. 262, Paris, France, 1952. Paper, 7 × 10¾ in., 187 pp., graphs, illus., tables, 1200 fr. A report on the conduct and results of various specialized aerodynamic investigations of the characteristics of airfoils and airscrews. In addition to the diagrams contained in the text, the technical data are presented in the form of some 80 graphs collected in a separate section at the end of the publication.

DEVELOPMENT OF THE GUIDED MISSILE. By Kenneth W. Gatland. Philosophical Library, Inc., New York, N. Y., 1952. Bound, 5¾ × 8¾ in., 133 pp., tables, diagrams, illus., $3.75. The author has gathered together the available facts on the evolution of guided missiles up to now, and describes their possible future developments. The range covered is indicated by the chapter headings: The new armament;

air-to-air missiles; problems of the supersonic rocket; rockets for high-altitude research; space-satellite vehicles; interplanetary flight. An appendix contains tabulated information on some 90 powered-missile types considered to be of significant importance.

GAS-TURBINE POWER. By G. M. Dusinberre. International Textbook Company, Scranton, Pa., 1952. Bound, $6\frac{1}{2} \times 9\frac{1}{2}$ in., 256 pp., tables, charts, illus., $6. An elementary text written from the viewpoint of the mechanical engineer. In treating the gas turbine as a prime mover the author discusses the basic gas-turbine cycle and its variations with emphasis on the thermodynamic and heat balance aspects. There are separate chapters on gas flow, compressors, combustion, heat transfer, and part-load operation. There is a bibliography.

DIE GESTALT DER ELEKTRISCHEN FREILEITUNG. By Milan Vidmar. Verlag Birkhäuser, Basel, Switzerland, 1952. Bound, $6\frac{3}{4} \times 9\frac{3}{4}$ in., 199 pp., 19.75 Sw. fr. An analytical treatment of the design of overhead power lines, which presents theoretical, mathematical solutions of a number of important transmission problems. The topics covered are shown by the chapter headings: the design problem; span length; the cross section through the three-phase conductor; diameter of the transmission line; the physical state of the transmission line; the problem of the conducting metal; the electromagnetic design of the overhead power line. Various other specialized aspects are dealt with within the several chapters.

HARWELL. The British Atomic Energy Research Establishment. 1946–1951. Philosophical Library, Inc., New York, N. Y., 1952. Bound, $6 \times 9\frac{3}{4}$ in., 128 pp., plates, $3.75. A description of the establishment, its operation, and its various programs, including the fundamental research work of a general or long-range nature. A special chapter deals with the protection of health and the detection of radiation. A reading list and a brief glossary are included.

HYPERGEOMETRIC AND LEGENDRE FUNCTIONS WITH APPLICATIONS TO INTEGRAL EQUATIONS OF POTENTIAL THEORY. (National Bureau of Standards, Applied Mathematics Series, No. 19.) By Chester Snow. G. P. O., Washington 25, D. C., 1952. Bound, $8 \times 10\frac{1}{2}$ in., 427 pp., $3.25. This is an outline of the theory of, and a collection of formulas pertaining to, the ordinary hypergeometric function with special reference to the associated Legendre functions. The linear and quadratic transformations and analytic continuations of the hypergeometric function of z to all parts of the z plane are written out at considerable length. Section 6 is an attempt to make accessible those transformations and properties of associated Legendre functions of general argument and parameters which are most commonly required in physics. This second edition has been rewritten and expanded.

MODERN PLASTICS ENCYCLOPEDIA AND ENGINEER'S HANDBOOK, 1952. Plastics Catalogue Corporation, New York, N. Y., 1952. Bound, $8\frac{1}{2} \times 11\frac{1}{2}$ in., 848 pp., tables, charts, illus., $2. As in the previous edition, this useful reference work presents in detail the recent developments in plastics engineering and methods, machinery and equipment, and plastics materials. The materials are now arranged in three sections: resins and molding compounds; chemicals for plastics; fillers and reinforcements. The directory section contains buyers' guides for materials, equipment, and so on; and an extensive list of trade names. The technical-data section now includes a fibers' properties chart, the plasticizers chart has been expanded, and the large folded plastics' properties chart is included as usual.

NUMERICAL METHODS IN ENGINEERING. By Mario G. Salvadori and Melvin L. Baron. Prentice-Hall, Inc., New York, N. Y., 1952. Bound, $5\frac{3}{4} \times 8\frac{1}{2}$ in., 258 pp., tables, charts, graphs, $6.65. Numerical methods using series expansions, successive approximations, and other nonanalytical solution methods are described with illustrative problems from the fields of mechanics, strength of materials, electricity, elasticity, plasticity, heat flow, vibrations, and so on. Finite difference theory is the unifying basis of the techniques which cover algebraic and transcendental equations, initial value and ordinary boundary-value problems, and partial differential equations. The numerical tools to which these techniques can be applied are the electric desk calculator and, in many cases, the slide rule.

REVIEWS OF PETROLEUM TECHNOLOGY. Volume 12, 1950. Edited by George Sell. The Institute of Petroleum, London, England, 1952. Bound, $6\frac{1}{4} \times 9\frac{1}{4}$ in., 513 pp., plus xxii p., charts, £2.10. Advancements in the field as written up during the year noted are discussed critically by British specialists under twenty-two major headings covering a wide range of topics: geology, drilling, production, refining, petroleum gases, Diesel fuels, lubricants, special products, internal-combustion engines, engine testing of fuels and lubricants, and petroleum legislation. A considerable bibliography is cited in addition to the literature references accompanying each chapter.

SYMPOSIUM ON ACOUSTICAL MATERIALS. American Society for Testing Materials, Philadelphia, Pa. (Special Technical Publication No. 123) 1952. Paper, 6×9 in., $1. Following a brief history of the acoustical-materials industry, five papers are presented dealing with the combustibility, maintenance, and basic physical properties of acoustical materials, the measurement of sound absorption, and the erection of acoustical tile.

THERMODYNAMICS OF ALLOYS. By Carl Wagner. Enlarged and revised edition of the Treatise from Handbuch der Metallphysik, translated by S. Mellgren and J. H. Westbrook. Addison-Wesley Press, Inc., Cambridge, Mass., 1952. Bound, $6\frac{1}{4} \times 9\frac{1}{4}$ in., 161 pp., tables, charts, $6.50. Following an introductory chapter on general thermodynamic relations the author discusses equations of state for solutions with substantially disordered atomic distribution and for solutions with substantially ordered distributions. Succeeding chapters cover heats of formation, free energies and activity coefficients, relations between thermodynamic functions and the phase diagram, and equilibria between liquid alloys and various melts (oxides, silicates, and so on). Emphasis is laid on principles but many data for specific systems are presented. Further information may be located through the alloy-index and the bibliography.

VERSUCHE AN EINEM RASCHLAUFENDEN ZWEITAKT - GEGENKOLBEN - DIESELMOTOR. (Mitteilungen aus dem Institut für Thermodynamik und Verbrennungsmotorenbau an der E.T.H., No. 10.) By A. I. Ibrahim Abdelfattah. Verlag Leemann, Zürich, Switzerland, 1951. Paper, $6\frac{3}{4} \times 9\frac{1}{2}$ in., 61 pp., illus., charts, diagrams, graphs, 7.30 Swiss fr. This report of tests on a high-speed, two-cycle, opposed-piston Diesel engine covers the following points: comparison of different fuel-injection systems; scavenging; control of friction losses in the engine; measurement and calculation of temperatures and heat flow in inlet and exhaust pistons.

WRITING THE TECHNICAL REPORT. By J. Raleigh Nelson. McGraw-Hill Book Company, Inc., New York, New York, third edition, 1952. Bound, $6\frac{1}{4} \times 9\frac{1}{4}$ in., 356 pp., charts, $4.50. The first part of the book presents a review of those fundamental considerations which bear on the design and composition of the report. The second gives specific directions for the form and style of the report, with several examples. The third outlines a systematic procedure for the critical examination of a report. The last two parts provide a summary of basic principles and a suggested series of assignments for classroom use. The whole is designed to supply a basic approach and pattern as well as the incidentals of form and convention.

YEAR BOOK OF THE HEATING AND VENTILATING INDUSTRY 1952. Issued in collaboration with the Association of Heating, Ventilating and Domestic Engineering Employers. Technitrade Journals Ltd., London, England. Bound, $5\frac{1}{2} \times 8\frac{3}{4}$ in., 284 pp., 73 pp.,; illus., 7s, 6d. The current edition of this annual publication offers a half-dozen technical articles, discussions of standards and contract agreements, a 50-page bibliography of articles published during 1951, a buyers' guide to British suppliers of heating and ventilating equipment, a list of British trade names, and other miscellaneous information connected with the industry and its organizations.

ASME BOILER CODE

Interpretations

THE Boiler Code Committee meets monthly to consider "Cases" where users have found difficulty in interpreting the Code. These pass through the following procedure: (1) Inquiries are submitted by letter to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.; (2) Copies are distributed to Committee members for study; (3) At the next Committee meeting interpretations are formulated to be submitted to the ASME Board on Codes and Standards, authorized by the Council of the Society to pass upon them; (4) They are submitted to the Board for action; (5) Those which are approved are sent to the inquirers and are published in MECHANICAL ENGINEERING.

The following Case Interpretations

were formulated at the Committee meeting October 31, 1952, and approved by the Board on December 31, 1952.

CASE No. 1022-1 (REOPENED)
(*Special Ruling*)

Inquiry: Is it permissible under the requirements of Section IX of the Code to test full size pipe and tubing that have dimensions too small to permit them to be tested in the guided-bend test jig?

Reply: It is the opinion of the Committee that the pipe or tube too small to be tested satisfactorily in a guided-bend test jig may be tested by means of a full size tension test. The specimen shall be of the dimensions and shall be tested as shown in Fig. 43. When so tested the

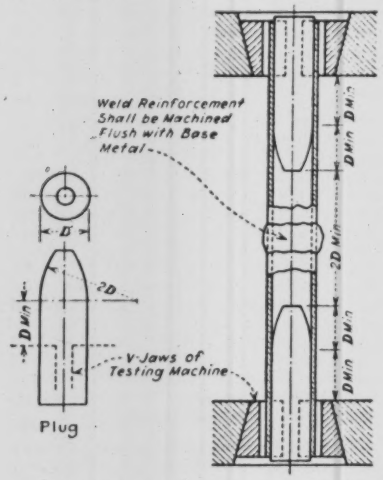


FIG. 43 TENSION SPECIMEN

specimen shall develop the full specified minimum tensile strength of the annealed base material (minimum of the range) when the tensile strength is covered in the material specification involved.

CASE No. 1110-2 (REOPENED)

Append to *Inquiry* "Are any special inspection requirements necessary for this class of piping?" In *Reply* delete paragraph (b); reletter succeeding paragraphs and revise present (c) to read:

(b) All welded joints over $^3/_4$-in. thick shall be examined for the detection of cracks by the fluid penetrant method. This examination shall be made following heat-treatment if heat-treatment is performed.

CASE No. 1120-1 (REOPENED)
(*Special Ruling*)

Inquiry: Is it permissible in welded construction conforming to the requirements of Section I and Section VIII to use low-alloy steel plate conforming to either of the following grades?

(1) $2^1/_4$ per cent chromium, 1 per cent molybdenum conforming to Specification SA-301, except that the chemical and physical requirements conform to Grade T-22 of Specification SA-213.

(2) 4 to 6 per cent chromium, $^1/_2$ per cent molybdenum conforming to ASTM Specification A-357-52T.

Reply: It is the opinion of the Committee that it is permissible to use the plate materials specified in the inquiry under the requirements of Section I or Section VIII of the Code with the following additional provisions.

(1) Complete radiographic examination is required for all welded butt joints.

(2) The maximum allowable stress values shall be those for the corresponding grade of Specification SA-213 in Table P-7 or Table UCS-23.

(3) The requirements for welding in Section IX shall be the same as for corresponding grades of Specification SA-213.

CAUTIONARY NOTE: Because of the different thermal coefficients of expansion of dissimilar materials, caution should be exercised in design and construction when welded with austenitic weld metal in order to avoid difficulties in service under extreme temperature conditions, or with unusual restraint of parts such as may occur at points of stress concentration and also because of metallurgical changes occurring at elevated temperatures.

CASE No. 1160 (*Special Ruling*)

Inquiry: May tubing manufactured by the electric-resistance-welding method to Specification SA-178 Grades A and C or SA-226 and subjected to the quality tests specified therein, be used for boiler, waterwall, economizer and superheater tubes that are enclosed within a setting, with design stresses equal to the permissible stresses for the base material?

Reply: It is the opinion of the Committee that electric-resistance-welded tubing made to Specification SA-178 Grades A and C or SA-226, may be used in the construction of boilers, waterwalls, economizers, and superheaters enclosed within a setting, for metal temperatures with the following permissible stresses:

Specification Number	For metal temperatures not exceeding degree F: −20 to 450	500	600	650
SA-178 A	11750	11750	11750	11750
SA-178 C	15000	15000	15000	15000
SA-226	11750	11750	11750	11750

700	750	800	850
11500	10700	9000	7100
14350	12950	10800	7800
11500	10700	9000	7100

CASE No. 1161 (*Special Ruling*)

Inquiry: May homogeneously lead-lined unfired pressure vessels be hydrostatically tested after the nozzles are completely lined?

Reply: It is the opinion of the Committee that the intent of the Code will be met, if the hydrostatic test of a lead-lined unfired pressure vessel is performed after the nozzles are completely lined with homogeneously-bonded lead.

CASE No. 1162 (*Special Ruling*)

Inquiry: Pending revision of the Code, may the new Porosity Standards be used in lieu of the standard radiographs referred to in the several sections of the Code?

Reply: It is the opinion of the Committee that pending revision to include reference thereto in the several sections of the Code, the Porosity Standards of the ASME Boiler and Pressure Vessel Code, approved by Council August 24th, 1951, may be used in lieu of the old standard radiographs. Copies of the new standards may be obtained at the Society headquarters.

Proposed Revisions and Addenda to Boiler and Pressure Vessel Code

AS need arises, the Boiler Code Committee entertains suggestions for revising its Codes. Revisions approved by the Committee are published here as proposed addenda to the Code to invite criticism. If and as finally approved by the ASME Board on Codes and Standards, and formally adopted by the Council, they are printed in the annual addenda supplements to the Code. Triennially the addenda are incorporated into a new edition of the Code.

In the following the paragraph numbers indicate where the proposed revisions would apply in the various sections of the Code.

Comments should be addressed to the Secretary of the Boiler Code Committee, ASME, 29 West 39th Street, New York 18, N. Y.

Power Boilers, 1949

PAR. P-268(e) Revise to read:

(e) *Reinforced Openings.* An opening in the shell of a boiler with a diameter greater than the maximum unreinforced opening permitted by (a) shall be provided with reinforcement. Openings of the reinforced type shall consist of one or more reinforcing rings or flanges

riveted, or welded, to the shell and/or a tube or pipe extension or fitting welded to the shell and/or welded to or integral with the reinforcing flange. The thickness of each independent riveted reinforcing flange or ring shall be not less than given in Table P-13.

Unfired Pressure Vessels, 1950

PAR. UG-99 Insert as new paragraph:

(j) The test pressure for shell-and-tube type equipment, such as heat-exchangers, in which tubes are rolled, welded, or brazed into tube sheets, shall be at least equal to, but need not exceed, $1\frac{1}{2}$ times the design pressure stamped on the vessel multiplied by the ratio of the stress value S for the temperature of the vessel during the test, to the stress value S for the design temperature.

Restore the two succeeding paragraphs to their original letter designations of (k) and (l).

PAR. UG-125(j) Delete

PAR. UG-125(k) Delete

PAR. UG-125(l) Reletter as paragraph (j)

PAR. UG-131(d) Add as new subparagraphs:

(1) A capacity certification test is required on a set of three valves for each combination of size, design, and pressure setting. The official capacity rating for each combination of design and size and test pressure shall be the smallest capacity rating of the three valves tested.

NOTE: The capacity ratings of a set of three valves shall fall within a range of 10% of the highest capacity. Failure to meet this requirement shall be cause to refuse certification of that particular safety valve design.

(2) If a manufacturer wishes to apply the code symbol to a design of safety valves, four valves of each combination of pipe size and orifice size shall be tested. These four valves shall be set at pressures which will cover the approximate range of pressure for which the valves will be used. The capacities as determined by these four tests shall be plotted against the absolute accumulation test pressure and a curve drawn through these four points. If the four points do not establish a reasonable curve, the authorized observer shall require additional valves tested. From this curve relieving capacities shall be obtained. The stamped capacity shall be 90% of the capacity taken from the curve.

PAR. UG-131(e) In the second line delete "an average."

PAR. UG-131(e)(2) In the paragraph below the definition of Z change "average" to "lowest."

PAR. UG-131(e)(3) At end of paragraph delete "and by the factor of 0.90."

PAR. UG-133 In paragraph (a) at end of sixth line insert "a pressure not exceeding," at beginning of eighth line change "remainder" to "additional valves"; in eighth and ninth lines delete "increasing at intervals of not more than 2 per cent"; at beginning of tenth line change "110" to "105," and at end of paragraph add "[See Par. UG-125(c)]."

Add as new paragraph:

(f) The set pressure tolerances plus or minus shall not exceed two pounds for pressures up to and including 70 pounds and 3 per cent for pressures above 70 pounds.

PAR. UG-134 Delete second paragraph of (a). Insert as new paragraphs:

(b) The opening through all pipe and fittings between a pressure vessel and its pressure-relieving device shall have at least the area of the pressure-relieving device inlet, and in all cases shall have sufficient area so as not to unduly restrict the flow to the pressure device. The opening in the vessel wall shall be designed to provide direct and unobstructed flow between the vessel and its pressure-relieving device.

(c) When two or more required pressure-relieving devices are placed on one connection, the inlet internal cross-sectional area of this connection shall be at least equal to the combined inlet areas of the safety devices connected to it, and in all cases shall be sufficient so as not to restrict the combined flow of the attached devices.

Reletter succeeding paragraph changing present "(b)" to "(d)"; "(c)" to "(e)"; "(d)" to "(f)"; and "(e)" to "(g)" and revise last sentence of new (g) to read:

The size of the discharge lines shall be such that any pressure that may exist or develop will not reduce the relieving capacity of the relieving devices below that required to properly protect the vessel.

FIG. UA-6 Detail D should be modified to agree with the corresponding sketch in the 1952 Code by making the weld reinforcement, a smooth curve without excess material and eliminating the radius shown as "2.5 t min."

Basis for Establishing Stress Values in Tables P-5, P-7, UCS-23 and UHA-23

The tables of stresses are grouped according to temperature, and in every case the temperature is understood to be the actual metal temperature.

In the determination of tabular stresses, the Subcommittee on Stress Allowances for Ferrous Materials is guided by successful experience in service with the particular steels in question in so far as evidence of satisfactory performance is available, such evidence being preferred to all forms of test data. However, in the evaluation of new materials, it is always necessary to be guided to a certain extent by the comparison of test information with similar data on successful equipment and in carrying out this process of examination and evaluation the subgroup finds the following considerations useful.

At temperature below the creep range allowable stresses are established at the lowest value of stress obtained from using 25 per cent of the specified minimum tensile strength at room temperature, or 25 per cent of the minimum expected tensile strength at temperature, or $62\frac{1}{2}$ per cent of the minimum expected yield strength for 0.2 per cent offset, at temperature. Below the creep range, no credit is allowed for any improvement in room temperature tensile strength by special heat treatment.

At higher temperatures the stresses are based on 100 per cent of the stress to produce a creep rate of $\frac{1}{100}$ per cent per 1000 hours, the values so chosen being based on a conservative average of many reported tests as evaluated by the subcommittee, greater weight being given to longer time tests in evaluating data. In addition to the above stated creep stress requirement, stresses in Table P-7 are limited to 60 per cent of the average stress to produce rupture at the end of 100,000 hours or 80 per cent of the minimum stress for rupture in 100,000 hours, whichever is lower but in Table UG-23 stresses are limited to 100 per cent of the stress to produce rupture at the end of 100,000 hours. In each table, the values chosen are based on a conservative average of many reported tests as evaluated by the subcommittee. In most cases the creep strength is well below the rupture strength. In only a few cases do the stresses listed approach the rupture strength. In a few cases the committee has approved stresses without any rupture test data on the specific composition, such approval being based on neighboring compositions.

In transition range of temperatures, the stress allowances are limited to values obtained from a smooth curve joining the low and high temperature ranges but lying on or below the curve of $62\frac{1}{2}$ per cent of the minimum expected yield strength at temperature.

In the choice of stresses in the range where a per cent of the tensile strength or yield strength governs, the limitations indicated above have been waived in certain cases, identified by footnote, as it was felt that higher stresses might be justified when deformation was not in itself objectionable, provided all other requirements are met.

For bolting materials, the stresses are established on the same basis as used for all other forms of materials. No credit is allowed for any improvement in tensile strength by heat treatment and the annealed strength for the alloyed bolting material is assumed to be not greater than 80,000 psi. For service at temperatures between —20 F to 400 F, it is permissible to use stresses equal to the lower of the following: 20 per cent of the minimum specified tensile strength or 25 per cent of the minimum specified yield strength; these specified properties apply to heat-treated material.

Stress values given herein for high temperatures represent the average properties of the materials under laboratory test conditions as obtained on tensile test coupons for test periods of 1000 to 10,000 hours. Where required, the design engineer must apply his own factor of safety to those values to provide for instability for oxidizing or corrosive atmospheres, for abnormal stress conditions, or for other design considerations which are not intended to be covered by basic properties of the materials.

ASME NEWS

With Notes on the Engineering Profession

Columbus Out to Break Records With 1953 ASME Spring Meeting Program

Deshler-Wallick Hotel, Columbus, Ohio, April 28–30

PLANS for the 1953 Spring Meeting of The American Society of Mechanical Engineers to be held in Columbus, Ohio, at the Deshler-Wallick Hotel, April 28–30, are rapidly shaping up and promise to be worthy of large enthusiastic audiences of engineers, as well as attractive to their visitors from allied fields.

The Columbus Section, taking advantage of its first opportunity to play host to a national meeting, has arranged a fine technical program—offering papers in the fields of machine design, hydraulics, gas turbines, fuels, power, production engineering, and management; tours of the world-famous industrial plants and research institutions located in the surrounding territory; the ASME Region V Student Conference, which will be held April 27 and 28 in Columbus, will afford the visiting students a close-up of a national meeting in operation; and for the women planning to attend the meeting there will be a splendid program for their enjoyment.

Luncheons and Banquets

Frederick S. Blackall, jr., president, ASME, will be the principal speaker at the President's Luncheon on Tuesday, April 28. This is to be a joint luncheon for the members and those student members who will be attending the Region V Student Conference and at this time the presentation of awards for the speaking contest will be made.

Governor Frank A. Lausche, of the State of Ohio, has accepted the invitation to be the Roy V. Wright Lecturer and will speak at the luncheon to be held on Wednesday, April 29.

At the banquet to be held Wednesday evening, James F. Lincoln, Mem. ASME, president and general manager of the Lincoln Electric Company, Cleveland, Ohio, will be the main speaker. The topic of his talk will be "Incentive Management."

Plant Trips

The committee for plant trips has made provision for groups to tour plants or institutions on Wednesday afternoon. The trips will start at 2:00 p.m. immediately following the luncheon. The list of trips includes The Jeffrey Manufacturing Company, which manufactures mining, material-handling, and processing equipment; North American Aviation Company (permission will be granted to visit the Columbus production facilities of the company if security regulations permit at the time of the meeting, North American has taken over the former Curtiss-Wright plants in Columbus and is engaged in production of the Navy FJ1 jet planes); Ternstedt Division of General Motors Corporation, this modern plant, about five years old, is engaged in the high-volume mass production of automobile parts and trimmings; the engineering and research laboratories of The Ohio State University; Battelle Memorial Institute; the National Electric Coil Company; and Denison Engineering Company. For a small group who may be interested in making an 80-mile trip, there is the interesting and rewarding tour of the Poston Station of Columbus and Southern Ohio Electric. This unique modern 200,000-kw plant, which has been in operation only three years, the last unit being under construction now, is located in the Southern Ohio coal fields—a conveyer system to bring coal directly from the tipple to the plant is under construction, and cooling towers are used to cool the entire quantity of water for the condensers.

COLUMBUS LOCAL COMMITTEE PREPARES FOR SPRING MEETING

(*Standing*, Ralph A. Sherman; *seated left to right*, Dan H. Vogel, Carl J. Lyons, Ernest B. Lund, Marion L. Smith, Harry C. Ballman, Richard B. Engdahl, Elmer R. Kaiser, James Purdy, representing Executive Committee; Walter L. Hartman, and Mrs. Bertrand Landry.)

Women's Program

The three-day program offers such attractions as coffee hours, the President's Luncheon, Tea at the Governor's Mansion, and a musicale at the home of Mrs. Elmer Kaiser. The entertainment is to be provided by Louise Y. McDonald, vocalist, and Mrs. S. H. Yost, accompanist. The second day there will be tours in the morning, a luncheon at the Scioto Country Club, and cocktails before the banquet in the evening. On Thursday the plans include a luncheon at the Maramor. Of course, as always, when the opportunity presents itself, there is shopping.

Students Urged to Attend

A cordial invitation is extended to everyone attending the meetings also to attend the social functions. The students are invited to attend the various sessions of the Spring Meeting before returning to their respective campuses as this is one of the rare opportunities they have for attending a national meeting of the Society.

The President's Page

Should Our Foreign Aid Program Be Reappraised?

AMERICAN engineers, who visited Europe last autumn, were invariably impressed with the great industrial expositions which were held in Germany, England, and Italy during August, September, and October, 1952. The variety and extent of the exhibits were startling testimony to the amazing recovery made by the European nations, and especially by our late enemies, from the ravages of war.

Germany's machine tool output, for example, has more than tripled in three years, and that nation today possesses some of the most modern industrial plants in the world.

Ironically, her new-found efficiency is largely the result of the blow-hot and blow-cold policies pursued by Germany's conquerors. During the immediate postwar period, the Morgenthau Plan held sway. The British and French virtually stripped Germany bare of her mechanical equipment and used it to re-equip their own war-damaged factories. This phase was followed by an abrupt and almost complete reversal of policy under the Marshall Plan. Brand new machines, purchased with ECA dollars, began to move into German plants, replacing those by then in use in England and France, most of which had been operated three shifts a day, seven days a week, throughout the long period of hostilities. As one German manufacturer remarked, "It's not a bad way to lose a war!" As a result, many German manufacturers claim to be able to produce at lower costs than any comparable manufacturer in the world.

The economic might which has been created overseas through our own largesse is already beginning to be felt in vigorous competition from abroad in our own domestic markets, frequently on a cut-price basis. To the extent that this acts as a primer to re-establish the two-way flow of international trade, this may be all to the good. However, one wonders whether American engineers and manufacturers will—or should—long view with equanimity the continuance of a subsidy to their overseas competitors which will enable the latter to undercut them at home.

Once Europe's industries are re-established and fairly well under way, they should be cast loose to proceed under their own power. That, indeed, was the original intent of the Marshall Plan.

Frederick S. Blackall, jr., *President*
The American Society of Mechanical Engineers

ASME Management Division Plans First Annual Meeting

Management Engineers Meet in Detroit, Mich., April 15-16

THE plans for the first annual conference of the Management Division of The American Society of Mechanical Engineers hail the inauguration of a new series of important yearly meetings. These meetings will be devoted to the problems relating to the management of engineering.

"The Administration of Engineering Activities" will be the theme of the two-day symposium to be held in the Rackham Memorial Building, Detroit, Mich., April 15-16, 1953, a subject suggested during an examination of the purposes of ASME Management Division. Some of the scheduled speakers at the conference were recommended to the Program Planning Committee by the Division members through a questionnaire issued by the Committee. These speakers include C. A. Wiken, vice-president in charge of engineering of the Rockwell Manufacturing Company; H. B. Riehl, Mem. ASME, vice-president in charge of engineering of the Proctor and Schwartz Company, who will speak on "What Management Expects From the Engineer"; and John Whitmore, director of public relations, Airborne Instruments Laboratories, Inc., who will speak on the subject "Integrating the New Engineer into the Engineering Organization."

F. S. Blackall, jr., president ASME, will give a dinner speech Wednesday, the 15th, and the tentative plans include luncheon speeches on Wednesday and Thursday. There will be two technical sessions held each day of the conference.

Session 1 will be devoted to the control of engineering functions; session 2, to the facilities for effective engineering. On Thursday the morning session will concern itself with the selection and training of engineers and the afternoon session, which will close the conference, will have as its topic for discussion the supervision of engineers.

The over-all program for this conference, the first of a continuing series of meetings to be devoted to management of engineering problems, is intentionally quite broad to provide at least partial answers to the range of major questions facing the engineering executive. In subsequent programs specific problems will be examined in greater detail.

A large attendance of engineers engaged in the management field is expected at the technical sessions based upon the reaction to the theme of the conference. The conference is sponsored by the Management Division under the direction of Arthur M. Perrin, chairman of the Division. T. E. Winkler will serve as general chairman of the conference representing the Detroit Section of the Society.

The Management Division is considering sites for the second annual Management Division conference which will be held in the spring of 1954.

AT THE ASEE ANNUAL DINNER, DARTMOUTH COLLEGE

(Arthur L. Williston, Mem. ASME (*left*), accepts from S. C. Hollister, Mem. ASME, dean of engineering at Cornell University and past-president, ASEE, the third James H. McGraw Award in technical-institute education. The presentation was made at the annual dinner of the Technical Institute Division of the American Society for Engineering Education, held at Dartmouth College, Hanover, N. H., June 24, 1952.)

Sir Harry Ricardo Receives 1953 James Watt International Medal

THE 1953 James Watt International Medal —perhaps the most coveted in the world of mechanical engineering—was awarded to Sir Harry Ricardo, Hon. Mem. ASME, technical director of Ricardo & Company, Ltd., Sussex, England, by The Institution of Mechanical Engineers. Sir Harry, who holds first place in internal-combustion-engine research in the world today, was chosen for this high honor for his contributions to knowledge of the fundamental principles of internal-combustion engines and the application of those principles to design and development.

Since his days as a youth at Rugby where he made "among other things, a coal-fired steam-motor-bicycle—a crude, dangerous, but most exciting machine," to receiving the 1953 James Watt International Medal, presented three days before his 67th birthday, is an unusually long and noteworthy list of contributions to his field of engineering. He has published some of the results of his research in volumes on "The Internal Combustion Engine" and "Engines of High Output," and a number of technical papers. (*See* An Autobiography: Harry R. Ricardo, Honorary Member, ASME, which appeared in MECHANICAL ENGINEERING, November, 1943, pp. 765-769.)

Presentation of the medal was made to Sir Harry at a General Meeting of the Institution on Friday, January 23.

Third Fluid-Mechanics Conference to Be Held in Minneapolis

THE third Midwestern Conference on Fluid Mechanics, sponsored by the Fluid Dynamics Division of the American Physical Society and the local sections of the American Institute of Chemical Engineers, the American Society of Civil Engineers, the American Society of Heating and Ventilating Engineers, The American Society of Mechanical Engineers, and the Institute of the Aeronautical Sciences, will be held March 23-25, 1953, at the University of Minnesota, in Minneapolis.

Plans for the conference are nearing completion. The subject matter of the technical sessions—approximately thirty-five contributed papers—is intended to embrace all aspects of theoretical and applied fluid mechanics.

Leading specialists in this field have accepted invitations to address the groups. Arrangements have been made for the complete proceedings to be published.

Further information may be obtained by addressing inquiries to Dr. Rudolf Hermann, General Chairman, Third Midwestern Conference on Fluid Mechanics, Institute of Technology, University of Minnesota, Minneapolis 14, Minn.

Plans For ASME Tours Announced

Preconvention Tour to Los Angeles; Postconvention Tour to Hawaii

A TWO-WEEK trip en route to The American Society of Mechanical Engineers Semi-Annual Meeting, to be held in Los Angeles, Calif., June 28-July 2, 1953, will be conducted if a sufficient number of members are interested. This trip will be arranged on a de luxe basis providing first-class rail transportation throughout, the best rooms in the finest hotels in all cities and National Parks.

The trip is arranged to start from Montreal. Arrangements have been made for others who may wish to join the trip at Winnipeg. Members, their relatives, and friends are urged to contact Ernest Hartford at ASME, 29 West 39th Street, New York 18, N. Y., by March 1, so that it may then be possible to notify all definitely regarding the trip and the time when a deposit must be made.

Itinerary to Los Angeles

The preconvention trip will provide an opportunity to enjoy many interesting stopovers. Starting after business on Friday, June 12, the tentative itinerary includes, in Canada, the following: Montreal, Lake Louise, Columbia Ice Field, Banff, and Waterton Lakes Park, and, in the United States, Glacier Park, Montana, Bryce Canyon, Zion Park, and North Rim Grand Canyon. The cost of the trip will be approximately $750 a person.

Postconvention Tour to Hawaii

According to the schedule which has been arranged, the ASME party will leave Los Angeles on July 3 by plane for Hawaii. The following proposed schedule allows two weeks to see leisurely all the isles of Hawaii and includes the Royal Hawaiian Hotel on the Beach of Waikiki as "home" in Honolulu. The return trip—five days of complete relaxation—to California will be made aboard the SS *Lurline* of the Matson Navigation Company.

Plans for Hawaii

From arrival in Hawaii to July 18, there will be a six-day tour of the islands and nine days at the Royal Hawaiian Hotel. The first day there will be a motor trip to Mount Tantalus, then a six-day tour of the islands of Kauai, Maui, and Hawaii. Depart Honolulu airport in the morning for Kauai. After lunch Kauai Inn, motor to lovely Hanalai and the Haena caves; night at Kauai Inn. Next day a visit to Spouting Horn and Waimea Canyon, with lunch at Kalalau Lookout. Dinner and night at Kauai Inn. Depart morning flight to Maui Island via Honolulu. From Naui airport drive to summit of Haleakala; after lunch at Silversword Lodge return to airport via Lao Valley; late afternoon flight to Hilo on Hawaii Island, with dinner and night at Naniloa or Hilo Hotel. Fourth day, motor to National Park and Kilauea Volcano; afternoon drive to Kailua, arriving at Kona Inn for dinner and night. Next day at Kona, with trip to Honaunau and Kealakekua; balance of day for leisure or visiting local historic points of interest. Sixth day, depart Kona airport in afternoon and return to Honolulu.

The next two days will be devoted to motor trips to Koko Head on the Kailua tour and the circle island tour of Oahu. The last six days will be free for leisure, shopping, and trips to other points of interest. Then board the SS *Lurline* on July 18, arriving in San Francisco on July 23. The cost of this trip is approximately $850 a person. Mr. Hartford will gladly answer any further questions on either or both of these trips.

Opportunities for Engineers Outlined at New York Meeting

FORTY-THREE faculty members representing 16 Eastern engineering colleges heard an outline of the opportunities and challenges facing young engineers in the electric-utility industry at an all-day meeting at the Biltmore Hotel, New York, Dec. 12, 1952. President Philip Sporn, Fellow ASME, and other executives of the American Gas and Electric Service Corporation, were the speakers and hosts.

Facing the mounting problem of recruiting technical graduates, the A. G. and E. executives attempted to show that engineering practice in the industry is constantly moving ahead. They emphasized that new engineering and operating problems arise almost daily in the course of their company's current eight-year, $680,300,000 expansion program and in its continuous search for more efficient operation in the face of rising costs.

As principal speaker, Mr. Sporn sought to convince the faculty representatives that A. G. and E. and its subsidiary companies—particularly by virtue of their constant research and development program and "pioneering" approach to many of the industry's problems—are a desirable choice of career for young engineers, both electrical and mechanical.

The session also afforded an opportunity for the college and university people to tell A. G. and E. what it could do to improve its job of "selling" college engineering students on the industry in general and its company in particular. Among other things, they pointed out, for instance, that college seniors usually have their field picked out well ahead of graduation and that the freshman class—or even high-school seniors—should be the recruiting "target."

The 43 professors, engineering-school officials, and placement representatives who attended represented the following colleges and universities: Columbia, Cornell, Syracuse, Lehigh, Rutgers, and Princeton Universities; Rensselaer and Worcester Polytechnic Institutes; Clarkson College of Technology; Universities of Connecticut, Rhode Island, Massachusetts, and Pennsylvania; Massachusetts and Stevens Institutes of Technology, and Polytechnic Institute of Brooklyn.

ASME Calendar of Coming Events

April 15–16
ASME Management Conference, Rackham Memorial Building, Detroit, Mich.
(Final date for submitting papers was Dec. 1, 1952)

April 28–30
ASME Spring Meeting, Deshler-Wallick Hotel, Columbus, Ohio
(Final date for submitting papers was Dec. 1, 1952)

May 24–28
ASME Oil and Gas Power Division Conference, Hotel Schroeder, Milwaukee, Wis.
(Final date for submitting papers was Jan. 1, 1953)

June 18–20
ASME Applied Mechanics Conference, University of Minnesota, Minneapolis, Minn.
(Final date for submitting papers was Feb. 1, 1953)

June 28–July 2
ASME Semi-Annual Meeting, Hotel Statler, Los Angeles, Calif.
(Final date for submitting papers was Feb. 1, 1953)

Sept. 21–25
ASME Industrial Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Chicago, Ill.
(Final date for submitting papers—May 1, 1953)

Sept. 28–30
ASME Petroleum Mechanical Engineering Conference, Rice Hotel, Houston, Texas
(Final date for submitting papers—May 1, 1953)

Oct. 5–7
ASME Fall Meeting, Hotel Sheraton, Rochester, N. Y.
(Final date for submitting papers—July 1, 1953)

Oct. 29–30
ASME Fuels Division and AIME Coal Division Joint Conference, Conrad Hilton Hotel, Chicago, Ill.
(Final date for submitting papers—June 1, 1953)

Nov. 29–Dec. 4
ASME Annual Meeting, Statler Hotel, New York, N. Y.
(Final date for submitting papers—July 1, 1953)
(For Meetings of Other Societies, see page 179)

RESA Charters Midwest Chapter

ANOTHER recognition of the Middle West as a growing center of technology was marked when a charter was presented to the Midwest Research Institute Branch of the Scientific Society of America. Installation of the chapter, one of 24 in the United States, was made by Donald B. Prentice, Fellow ASME, director of the national society.

The society was founded in 1947 under the auspices of Sigma Xi, national honorary research society, to foster "encouragement and recognition of original investigation in pure and applied science." It provides the same recognition for industrial researchers that Sigma Xi provides for academic research. Members of the society represent a cross section of the major fields of science.

According to M. P. Thornton, president of the Kansas City section, it will be the aim of the Midwest Research Institute group to promote research at a higher level in the educational and industrial laboratories of the area, and at the same time, weld together those many fields of science so prevalent in the region.

Revision of AIEE-ASME Preferred Standards for Steam Turbine-Generators

THE Board of Directors of the AIEE and the Council of the ASME has approved revisions of AIEE Standards 601 and 602 and ASME Standard No. 100, "Preferred Standards for Targe 3600-rpm, 3-phase, 60-cycle Condensing Steam Turbine-Generators (Larger than 10,000-kw Rated Capacity)."

The major changes in the standards consist of the following:

The expression "Turbine Capability" has been eliminated. The figures that were previously used as the turbine capability are now called "Turbine Rating." This decision resulted from a feeling that confusion existed in the industry because of a turbine rating of one figure with a capability of 10 per cent greater. The trend in this country and abroad has been to use only a single rating and this has been selected as that of the old capability. This has meant a revision of the saturation temperatures at the various extraction openings to correspond with the new rating.

The rating of the previously selected largest machine of 99,000-kw capacity has been changed to 100,000 kw in order to round out the figure. This has meant slight changes in the rating of the generator.

A new turbine has been added with a rating of 150,000 kw. The generator rating on this machine bears the same relation to the turbine rating as on the existing machines. This is a reheat machine 1800-psig throttle pressure, 1000/1000 F temperature with seven extraction openings. The voltage of the new generator has been established at 18,000 volts.

All hydrogen-cooled generators have been made suitable for 30-psig hydrogen pressure and have been given capabilities at this pressure of 25 per cent above the rating at 0.5-psig hydrogen pressure.

The paragraph on "Excitation" has been made more strict in requiring that the exciters shall operate within their voltage rating with the generators operating at their 30-psig hydrogen-pressure capability.

Editorial changes have been made throughout as necessary and the preliminary paragraphs have been revised to explain the development of the Standards.

The essential characteristics of the turbine generators are shown in the table on this page.

Price per copy is 60 cents. Order from ASME Order Department, 29 West 39th Street, New York 18, N. Y.

Industry-Education Team Plans Engineering Research

A WORKING partnership between industry and education that will bring the problems of the factory to the research laboratories of the campus has been formed by Pratt Institute, Brooklyn N. Y., technical college, and Charles Engelhard, Inc., Newark, N. J., manufacturers of industrial instruments. Under a grant recently made by the Newark firm, research in the design and development of industrial instruments will be carried out at Pratt Institute by faculty members and students.

Major problem to be studied in behalf of the Newark firm is the design of flowmeters. Special emphasis will be given to the calorific flowmeter.

Aim of the long-range program is to make possible the building of highly dependable instruments that can measure all fluids regardless of differences in viscosity, chemical properties, and thermal conductivity.

ASEE Meeting Featured in Manhattan College Centennial Celebration

THE annual winter meeting of the Middle Atlantic Section of the American Society for Engineering Education was held Saturday, December 6, 1952, on the campus of Manhattan College. The event was another in a series of observances in 1952 by the College in commemorating its one-hundredth anniversary.

Nineteen member colleges and universities of the Middle Atlantic Section attended the one-day meeting starting at 9 a.m. Representatives were: Brooklyn Polytechnic Institute, N.Y.U., C.C.N.Y., Cooper Union, Pratt Institute, Columbia, Manhattan, and

PREFERRED STANDARDS FOR LARGE 3600-RPM 3-PHASE 60-CYCLE CONDENSING STEAM TURBINE-GENERATORS

	Air-Cooled Generator	Hydrogen-Cooled Generators Rated for 0.5-Psig Hydrogen Pressure								
*Turbine rating, kw	12,650	16,500	22,000	33,000	44,000		66,000		100,000††		150,000
Generator rating, kva	13,529	17,647	23,529	35,294	47,058	47,058	70,588	70,588	106,951	106,951	160,428
power factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
short-circuit ratio	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.8	0.8	0.8
Throttle pressure, psig	600	850	850	850	850	1250	850	1250	1450	1450†	1800†
Throttle temperature, F	825	900	900	900	900	950	900	950	1000	1000	1000
Reheat temperature, F	...	...	...	...	...	...	...	...	...	1000	1000
Number of extraction openings	4	4	4	5	5	5	5	5	5	5	7
Saturation temperatures at openings at "turbine rating" with all extraction openings in service, F											
1st	180	180	180	180	180		180		185	180	150
2nd	240	240	240	240	240		240		250	245	185
3rd	290	290	290	290	290		290		310	305	235
4th	360	360	360	360	360		360		385	375	280
5th	...	...	...	420	420		450		420	450	325
6th	...	...	...	...	...		...		...	...	375
7th	...	...	...	...	...		...		...	...	455
Exhaust pressure, inches Hg abs	1.5	1.5	1.5	1.5	1.5		1.5		1.5	1.5	1.5
Generator capability at 0.85 power factor and 15 psig hydrogen pressure, kva	...	20,294	27,058	40,588	54,117		81,176		122,994		184,492
Generator capability at 0.85 power factor and 30 psig hydrogen pressure, kva	...	22,059	29,411	44,118	58,822		88,235		133,689		200,535

A tolerance of 10 F shall apply to above saturation temperatures. Tolerances shall be unilateral, if possible, so as not to reduce the spread in temperature between adjacent extraction openings.

* The turbine rating is guaranteed continuous output at generator terminals when the turbine is clean and operating under specified throttle steam pressure and temperature and 2.5 inches Hg abs exhaust pressure, with full extraction from all extraction openings.

† A 10 per cent pressure drop is assumed between high-pressure-turbine exhaust and low-pressure-turbine inlet for the reheat machines.

†† These are two different turbines, the first for regenerative-cycle operation, and the second a machine for reheat-regenerative-cycle operation.

West Point from the New York area; Lafayette, Swarthmore, The University of Pennsylvania, Villanova, Lehigh, and Drexel Institute from Pennsylvania; Newark College of Engineering, Rutgers, Princeton, and Stevens Institute of Technology from New Jersey; and the University of Delaware.

After registration and an inspection of the laboratories and campus of Manhattan College, the morning general session commenced with Prof. William B. Plank of Lafayette acting as chairman. The representatives were welcomed by Brother Bonaventure Thomas, F.S.C., president of Manhattan.

Industry as well as education was represented on the various panels of discussion. Industrial-engineering experts who were present included: William J. McCarthy, manager of engineering, N. Y. Telephone Co.; Dwayne W. Orten, director of education, IBM Corporation; C. S. Purnell, manager, Eastern Electric Utilities, Westinghouse Electric Corporation; and Ford Bartlett, president, Lockwood, Kessler and Bartlett, Inc., New York.

Topic for the morning session was "The Role of Professionalism in Engineering Education," while in the afternoon it was "Transition—College to Training in Industry." The remainder of the afternoon was devoted to group meetings and round-table discussions. The day ended with a dinner in the College dining hall with a few brief remarks by Professor Plank.

There was a special ladies' program at the United Nations Building for the women guests of the representatives. Prof. Robert T. Weil, Jr., head of Manhattan's electrical-engineering department, served as chairman of the meeting's arrangements committee.

Canadian Universities Report Great Registration of Engineering Students

REGISTRATION of first-year engineering students at Canadian universities was 34 per cent higher in 1952 than in 1951, according to the annual survey recently completed by The Engineering Institute of Canada.

This survey indicates that 2865 first-year students registered in engineering courses for 1952–1953 as compared to 2105 for 1951–1952, and 1874 for 1950–1951. The percentage increase last year was 14 per cent, so that there are now approximately 50 per cent more students taking first-year engineering than there were two years ago.

For the first time in some years enrollment of engineering students in all years is up from the previous year by a small margin and the total registration is 8230.

The number in the graduating classes is again lower than a year ago and amounts to 1357, which is more than 20 per cent less than the number registered in 1951–1952. A still further reduction is forecast for the 1954 graduating class but in 1955 a small increase may be expected.

The relative proportion of total registration in different courses continues to show little change from previous years.

The Historical and Legal Background of Patent Rights

"THE Historical and Legal Background of Patent Rights" was the title of a paper delivered by Herbert J. Krase, assistant director of the patent department of Monsanto Chemical Company on Monday, Dec. 8, 1952, before the forty-fifth annual meeting of the American Institute of Chemical Engineers in Cleveland, Ohio. Mr. Krase traced the history and development of the patent laws from the early concepts and practices in Venice (1474 A.D.) to the present-day U. S. patent laws.

"A patent is not a 'monopoly' in the sense in which the public understands this term," said Mr. Krase. He compared the personal rights under a patent to those of ownership of real estate or personal property, and indicated that if our society is based on recognition of private right to ownership of property, "then it must logically recognize a parallel right of ownership in a patent." He also distinguished between the patent laws and the Sherman Anti-Trust law, which declares monopolies illegal, stating that "a valid patent grant is not a monopoly in the sense in which the Sherman Act employs the term." However, if a patent is used so as to restrict the rights of the public beyond the rights granted by the patent, such misuse then falls into the field controlled by the anti-trust laws.

Mr. Krase also compared our patent system with those of foreign countries. The U. S. Patent System, he said, differs from all others in giving an unconditional grant to the owner.

In foreign countries, this grant is conditioned on a working requirement, compulsory licensing provisions, and payment of annual taxes.

He pointed to the great advantages of our system and stated that as long as the U. S. Patent System is "available to great and small alike, coupled with availability of risk capital, we need have no fear for the American System of free enterprise. . ."

All ASME Members Urged to Attend Business Meetings

THE ASME Business Meetings are are held twice yearly—during the Semi-Annual Meeting and the Annual Meeting. As a first step to increase attendance and create greater interest in these Business Meetings, it has been suggested that the time allotted for discussion by the members be lengthened.

Remember these meetings are intended primarily as an opportunity for members to discuss any business, suggestions, new ideas, and problems in which they are interested as an open forum.

Therefore, in an attempt to encourage greater attendance and foster interest, the next Business Meeting to be held in conjunction with the Semi-Annual Meeting, at the Hotel Statler, Los Angeles, Calif., will commence at 4:30 p.m., in order to allow at least one full hour for discussion by the members.

COLLEGE-INDUSTRY LEADERS MEET TO DISCUSS MATERIAL-HANDLING EDUCATION

(Six university leaders, Columbia, Cornell, Massachusetts Institute of Technology, Michigan State, Purdue, and Wayne, in material-handling education, meet with equipment manufacturer and user executives to support broader curricula and greater student interest in material-handling engineering as a career. The committee laid plans for a seminar of college and university faculty men on "Teaching Material Handling" to be held in Philadelphia, Pa., on Sunday, May 17, 1953, preceding the fifth national Material-Handling Exposition. The College-Industry Committee on Material-Handling Education is sponsored jointly by the Material Handling Institute and the American Material Handling Society, and convened for its third planning session at the Hotel Commodore in New York, N. Y., Dec. 16, 1952. *Standing left to right:* V. J. Reade, Mem. ASME, Whitehead Metal Products Company; H. T. Amrine, Mem. ASME, Purdue; E. W. McCaull, Jervis B. Webb Company; W. V. A. Clark, M.I.T., Committee vice-chairman; J. M. Apple, Mem. ASME, Michigan State; D. H. Bitney, Union Steel Products Company; B. W. Saunders, Mem. ASME, Cornell. *Seated:* A. K. Strong, American Cyanamid; H. M. Palmer, president, MHI, 1953, Lewis-Shepard Products Company; S. A. Larsen, Wayne University, chairman of Committee; J. W. Wunsch, Silent Hoist & Crane Company; I. M. Footlick, secretary of Committee; F. C. Winter, Mem. ASME, Columbia.)

ASME Standards Workshop

ABC Conference to Be Held in New York

SECTIONAL Committee B4 on Limits and Fits, met on Dec. 4, 1952, to discuss the fifth draft of Canadian Standards Association B97, which was drawn up as a result of a meeting in Canada in September, 1952. Discussion of CSA B97, fifth draft, was complete and comprehensive covering two aspects of the matter: Action to be taken by the B4 delegation at the ABC Conference to be held in the Engineering Societies Building, New York, N. Y., Feb. 9–11, 1953, and acceptability of the Canadian proposal as a basis for a possible American Standard. Various objections and comments finally crystallized into three general categories: The Canadian proposal may be too complicated and voluminous for practical use in this country; the table of nominal-size ranges might be unacceptable to American industry since the values are inch conversions from metric values and not basically arranged with inch units in mind; and the letter and number symbols for fits in some cases would be unacceptable as they would conflict with present American Symbols. The B4 delegation to the ABC Conference was instructed to work for a different and less confusing system of symbols for fits and to attempt to get agreement on inch values for size ranges, rounded to a reasonable fraction.

Coming Meetings

Practical Lubrication

FOR the second consecutive year, a helpful seminar on industrial lubrication engineering will be sponsored by the Philadelphia Section of the American Society of Lubrication Engineers.

Scheduled to start Tuesday evening, Feb. 10, 1953, at the Bellevue-Stratford Hotel, Philadelphia, Pa., the educational course will continue for four more consecutive Tuesdays, ending on March 10.

The seminar will include detailed explanations and instructions on such subjects as lubricant dispensing equipment, planning and installing complete lubrication maintenance programs, theory and application of drawing compounds and cutting oils, and other allied subjects.

For further information or application forms, contact C. R. Schmitt, E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

Instrumentation

THE electrical-engineering department of Michigan State College, in co-operation with the National Science Foundation, the National Bureau of Standards, the Instrument Society of America, and the American Society for Engineering Education, announces an invitational National Collegiate-Industry-Government Conference on Instrumentation to be held at the Kellogg Center, on its campus, March 19–20, 1953.

The conference is being called in recognition of the growing importance and potential of instrumentation in research and production, and to the national defense.

The tentative program of papers to be presented in the technical sessions list such titles as What is Instrumentation? The Challenge of Instrumentation as a Science, Meeting Instrumentation Needs of the Production Industries, the Process-Control Industries, and of the Instrument Manufacturing Industries; and reports from educational institutions, government agencies, and industry also will be given.

Educational and industrial administrators, and others interested in the field of instrumentation who would like additional information concerning the conference should write to Prof. R. J. Jeffries, Department of Electrical Engineering, Michigan State College, East Lansing, Mich.

1953 Society Records Sent Upon Request

MEMBERS of The American Society of Mechanical Engineers who wish to receive copies of ASME Membership List (AM 1), January 1953, and the 1953 issue of Personnel of Council, Boards, and Committees: With Other ASME Records (AC-10), should address their requests to the Secretary, ASME, 29 West 39th Street, New York 18, N. Y.

Management, Labor, and the Instrument Department

THE New Jersey Section of the Instrument Society of America is scheduling its fifth annual conference and symposium on April 3, 1953. The subject chosen is Management, Labor, and the Instrument Department. The aim of the symposium will be to explore the relationship between management and labor as it affects the instrument department, and to focus attention on the problems of obtaining production results.

Electronic Components

THE American Institute of Electrical Engineers, Institute of Radio Engineers, Radio-Television Manufacturers' Association, and West Coast Electronic Manufacturers Association are co-operating in the presentation of the 1953 Electronic Components Symposium to be held in the Los Angeles area. The Symposium will take place on April 29, 30, and May 1, 1953, at the Shakespeare Club in Pasadena, Calif. The purpose of this meeting is to bring together all those who share an interest in the development, design, performance, and future of electronic component parts.

Technical papers are now being considered for the formation of the program for this meeting. For further information, inquiries should be directed to Dr. A. M. Zarem at the Electronic Components Symposium headquarters, Stanford Research Institute, Suite 1011, 621 South Hope Street, Los Angeles 17, Calif.

Education

Industrial Management

THE long-established Executive Development Program, covering one year of advanced study in industrial management at the Massachusetts Institute of Technology, will be substantially expanded in 1953–1954.

E. P. Brooks, dean, M.I.T. school of industrial management, announced plans for the 1953–1954 program and for the Sloan Fellowships which will be awarded to its members. The fellowships will be given to young industrial executives who have already demonstrated their ability to grow into major management responsibilities and who are assured of opportunities for constructive leadership in their companies.

A nationwide competition for fellowships to the Program, under a grant of funds from the Alfred P. Sloan Foundation, Inc., will close on Feb. 21, 1953.

Participation in the Executive Development Program is limited to recipients of Sloan Fellowships. Nomination by an employer is a prerequisite, since employers co-operate in the program by sponsoring these men and by providing successful candidates with a year's leave of absence and financial aid. Fellows are drawn from both large and small companies in various types of industry.

Candidates must be between the ages of 30 and 35 and they should have at least five to ten years of industrial experience, with part of this experience in a managerial capacity. Fellowship winners will be selected on a competitive basis by M.I.T. after consideration of the applicants' records and references and after consultation with their employers.

Complete information on the Executive Development Program and application blanks for Sloan Fellowships may be obtained from the Director of the Executive Development Program, M.I.T. School of Industrial Management, 50 Memorial Drive, Cambridge 39, Mass.

Rust Engineering Scholarship at Lehigh

THE Rust Engineering Company of Pittsburgh, Pa., has established a scholarship fund at Lehigh University with a gift of $25,000. The income from this fund is to be used for one or more students in engineering.

Winners of scholarship awards under this fund are to be chosen by the university committee on scholarship grants on the basis of "financial need, character, and well-adjusted personality, intelligence, and above-average potential."

The scholarship is to be known as The Rust Engineering Company Fund. The company,

acting through S. M. Rust, one of the founders of the company, and chairman of its board of directors, took the action to honor the memory of the other co-founders, E. M. Rust and E. J. Lee Rust. S. M. Rust, Jr., Mem. ASME, president of the company, is a graduate of Lehigh University with the class of 1934. George M. Rust, Mem. ASME, a graduate in 1931, is vice-president of the company and son of E. J. Lee Rust.

Jet Propulsion

THE Daniel and Florence Guggenheim Foundation will grant a total of $36,000 for 1953 Guggenheim Jet Propulsion Fellowships for graduate study in rocket and jet-propulsion engineering at the California Institute of Technology and at Princeton University, according to an announcement made by Harry F. Guggenheim, president of the Foundation, who said applications are now being accepted by the Foundation for their Fellowships.

The purpose of the Fellowships is to select and train outstanding men for basic research and leadership in the future development of rockets and jet propulsion. The sum of $18,000 is available for Fellowships at each school, and a total of from 18 to 24 grants will be awarded to qualified applicants. Each grant provides an allowance for living expenses and the university provides for tuition.

Candidates for Daniel and Florence Guggenheim Jet Propulsion Fellowships must be residents of the United States; must have outstanding technical-ability and leadership qualities, deep interest in the development of rockets and jet propulsion, and an intention to follow this field as a career; and must be suitably prepared for graduate study in this field.

For application blanks write to The Daniel and Florence Guggenheim Foundation, 120 Broadway, New York 5, N. Y.

Cornell Mechanical-Engineering Scholarship

A FULL-TUITION scholarship of $820 a year for the study of mechanical engineering at Cornell University has been established by Mrs. Anna Jessel-Whyte of Kenosha, Wis., in memory of her son, Jessel Stuart Whyte, who died on May 28, 1952, and who received a mechanical-engineering degree at Cornell in 1913.

The scholarship will be given to a freshman entering Sibley school of mechanical engineering at Cornell, as selected by the school's scholarship committee. He may keep the scholarship for the entire five-year course if his grades are satisfactory.

Among applicants of equal qualifications, preference will be given to those from Wisconsin, Illinois, Minnesota, Iowa, and Michigan.

Corrosion

AN award of $50 will be made to an author 35 years of age or younger, for the best paper on corrosion published during 1953 in *Corrosion*, official monthly periodical of the National Association of Corrosion Engineers. The award, funds for which are being supplied by an anonymous donor, will be made by a committee appointed by the NACE president, which will include members of the association's Editorial Review Committee.

Further information and a copy of the NACE "Guide for the Preparation and Presentation of Papers" may be obtained by writing to A. B. Campbell, Executive Secretary, National Association of Corrosion Engineers, 1061 M & M Building, Houston 2, Texas.

Meetings of Other Societies

Feb. 16–19
American Institute of Mining and Metallurgical Engineers, annual meeting, Hotel Statler, Los Angeles, Calif.

March 2–6
American Society of Civil Engineers, winter conference, Fairmont Hotel, San Francisco, Calif.

March 2–6
American Society for Testing Materials, spring meeting, Hotel Statler, Detroit, Mich.

(*ASME Calendar of Coming Events, see page 175*)

Junior Forum

Conducted by Joseph Schmerler[1]

Juniors' Nationwide Response Is Heartening

IN the December issue of MECHANICAL ENGINEERING, the Junior Forum carried an appeal for "Corresponding Members" to assist the National Junior Committee in its work and to form a nucleus of sincerely active Juniors who can be appointed to the Committee itself or who can assume other responsible positions within the Society.

The response to this appeal has been most heartening. The wide interest shown was not restricted to any one geographical location or to one industry. Replies have been received from numerous sections of the country where Juniors are engaged in widely varied applications of mechanical engineering. For example, Juniors who work for automotive-parts manufacturers, aircraft and aircraft parts, fabricators, pump manufacturers, power companies, synthetic-fiber producers, gas and oil companies, communications, and construction outfits, in Michigan, New York, Indiana, South Carolina, Massachusetts, New Jersey, and Virginia are among those who have responded to our appeal. This is exactly the type of representation which the National Junior Committee wishes to build in order to give diversity to the views expressed in its activity.

[1] Design Engineer, Celanese Corporation of America, New York, N. Y. Jun. ASME.

To expand somewhat the description of Committee activity which was contained in the December Junior Forum, there are ten members on the executive group of the Committee whose tenure of office is for five years. This means that two new members are appointed annually. The General Committee, however, can contain any number of Juniors who may be asked to assist in subcommittee activity or appointed as Junior Representatives to the other Society committees.

There is obviously a great opportunity to assume active positions in the Society because of the large number of openings which must be filled. Also, since the Society conducts four national meetings a year in various sections of the country, it gives people in these Regions an even greater opportunity to participate.

Because the first appeal for "Corresponding Members" was warmly received, the National Junior Committee wishes to continue to extend an invitation to "come on in, the water's fine." To those who did not read the December article, and to those who are on the fence, we hope that this will arouse greater interest to join in the Society activities. All you need do is address a short note stating your intention and a short description of your work to Junior Forum, Editorial Department, MECHANICAL ENGINEERING, 29 W. 39th St., New York 18, N. Y.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, Dec. 17, 1952

A MEETING of the Executive Committee of the Council was held in the rooms of the Society on Dec. 17, 1952. F. S. Blackall, jr., chairman, presided. In addition to Mr. Blackall, there were present: H. E. Martin, A. C. Pasini, E. S. Theiss, and W. F. Thompson of the Committee; E. J. Kates, assistant treasurer; E. G. Bailey, past-president; H. R. Kessler, vice-president; C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary. The following actions were of general interest.

Custodian Fund for Joint AIEE-ASME Subcommittee

The committee voted to establish a custodian fund for the Joint AIEE-ASME Subcommittee on a Recommended Specification for the Speed Governing of Internal-Combustion-Engine Generator Units. This arrangement is to be reviewed annually.

Reinstatement of Resigned Members

Upon recommendation of the Membership Review Committee, it was voted to revise the

present terms for reinstatement of resigned members to include a provision for a fee of $10 to accompany request for reinstatement. A copy of the Policy of the Society on Terms for Reinstatement of Resigned Members is available on request.

Committee on Society Policy

At its meeting of Nov. 30–Dec. 1, 1952, the Council approved a recommendation of the Committee on Society Policy which requires a study to determine why such a large number of Junior Members dropped from the Society during the previous year. Upon the request of the vice-presidents for a task group, President Blackall appointed Messrs. Theiss and Pasini to nominate a working group of three men located in or near Detroit to carry on this study.

A second recommendation of the Committee involved appointment of a subcommittee to study possibilities of an active postcollege training and orientation program in communities where younger engineers live. The Board on Education and Professional Status was asked to review this plan in more detail.

Air Pollution Controls Committee

Because it was found that the work of the Committee on Air Pollution Controls related more closely to the Society's research activities, it was voted to transfer the jurisdiction of the Committee from the Board on Codes and Standards to the Board on Technology.

Exhibition Hall

The Committee's attention was called by President Blackall to plans being made for a Coliseum in New York City with a 225,000-sq ft exhibition hall. He stated that European halls were much larger and that there was no hall suitable for a large exhibition of heavy machinery. The Committee recorded its support of the president's efforts to secure a more suitable exhibition hall.

1952 Power Show

The secretary reported a payment of $15,500 from the International Exposition Company in accordance with the Society's agreement regarding its participation in the 1952 Power Show. The Committee voted to authorize crediting this sum to the Research Reserve.

Engineering Index

On the recommendation of Messrs. Kopf and Davies, the Committee voted to authorize an agreement whereby the Engineering Index, Inc. will pay to the ASME, for the use of its name and facilities for the year 1953, the sum of $2500 plus the complete unit of services now given.

Certificates of Award

Certificates of award were presented to the following retiring chairman of Boards and Committees: D. W. R. Morgan, Board on Membership; A. A. Potter, Board on Public Affairs; L. E. Herbert, Constitution and By-Laws Committee; J. M. Gallalee, Engineers Registration Committee; K. M. Irwin, Organization Committee; J. A. Willard, Professional Divisions Committee; and P. V. Miller, Standardization Committee.

The following retiring chairmen and members of the executive committees of Professional Divisions were also awarded certificates: R. E. Peterson, Applied Mechanics; R. B. Lea, Aviation; W. E. Reaser, Fuels; W. J. King, member, Gas Turbine Power; G. L. Tuve, member, Heat Transfer; H. S. Van Patter, Hydraulic; H. L. Mason, member, IIRD; D. V. Waters, Machine Design; E. H. MacNiece, Management; W. D. Stoddart, Materials Handling; S. C. Massari, Metals Engineering; B. B. Morton, Petroleum; R. M. Van Duzer, Power; E. L. Knoedler, Process Industries; J. W. Huckert, Production Engineering; C. B. Bryant, Railroad; G. W. Neely, Rubber and Plastics; J. V. Grimaldi, Safety; S. B. Earle, member, Textile Engineering; R. R. Smith, Wood Industries.

Harvey N. Davis

The Committee noted with regret the death on Dec. 3, 1952, of Harvey N. Davis, Hon. Mem. and president of the Society in 1938.

Appointments

The following appointments were approved: G. V. Williamson to Special Committee on Turbine Standards; and Emmart La Crosse and Baldwin N. Woods, AAAS.

EJC Prepares for Reorganization

ADOPTION of a new constitution by Engineers Joint Council became effective on Dec. 7, 1952, when the American Institute of Chemical Engineers voted approval, thus becoming the fourth of the five constituent societies to take such action. The text of the new constitution will be found elsewhere on this page.

Under the new constitution a new procedure is provided for the appointment of representatives of the five constituent societies from their boards of direction or officers. ASME representatives are: R. J. S. Pigott, B. P. Graves, R. I. Goetzenberger, C. E. Davies, and Frederick S. Blackall, jr., ex officio. Alternates are E. J. Kates, L. J. Cucullu, H. R. Kessler, and A. C. Pasini. Also provided in the new constitution is a different method of electing officers of EJC. Under the new constitution the president of the Council is to be elected by the Council for a term of one year, from the membership of the Council. The vice-president is to be elected under similar conditions, but he must be a "representative of another constituent society than that represented by the president."

Since the Council must be organized in accordance with the provisions of the new constitution, an organization meeting was scheduled for January 23. The actions of that organization meeting will be reported later.

Seven Societies Invited to Join EJC

At a meeting of the Engineers Joint Council held on Nov. 21, 1952, the Executive Committe was authorized to extend invitations to seven engineering societies to join EJC on the basis of the new constitution. The seven approved societies are: The American Association of Engineers, American Society for Engineering Education, American Society of Heating and Ventilating Engineers, The Institute of the Aeronautical Sciences, Institute of Radio Engineers, National Society of Professional Engineers, and the Society of Naval Architects and Marine Engineers.

At a meeting of the Executive Committee of EJC held in New York on Dec. 15, 1952, with Vice-President T. H. Chilton presiding, Col. W. H. Carey reported on progress being made toward incorporation of EJC. The Committee voted to send formal letters of invitation to join EJC to the seven engineering societies listed in the foregoing paragraph.

Salary Survey

It was reported that at a meeting of the Committee on Secretaries with the chairman and secretary of the Special Surveys Committee, it was decided that the Special Surveys Committee would undertake a salary survey on a profession-wide basis through employers and engineers.

World Power Conference

The secretary was authorized to write to H. C. Forbes, of the World Power Conference, to inform him that EJC was prepared to take over the secretarial functions of the U. S. National Committee of the World Power Conference.

Unionization of Engineers

Following a discussion of the growth of trade-union activity in the engineering profession, the Executive Committee requested the Labor Legislation Panel to prepare a basic statement on the subject.

EJC Adopts New Constitution

WITH the official approval of the American Institute of Chemical Engineers on Dec. 7, 1952, the fourth constituent society of Engineers Joint Council to take such action, the new EJC Constitution became effective. The text of the new constitution follows.

Article I

Name and Objectives

1 The name of this organization shall be Engineers Joint Council.

2 The objectives of the Council shall be:
(*a*) To advance the general welfare of mankind through the available resources and creative ability of the engineering profession.
(*b*) To promote co-operation among the various branches of the engineering profession.
(*c*) To develop sound public policies respecting national and international affairs wherein the engineering profession can be helpful through the services of the members of the engineering profession.

3 To achieve these objectives, the Council shall:

(*a*) Act as an advisory and co-ordinating agency to seek and study matters of mutual interest to the constituent societies of Council and to recommend parallel action by them.
(*b*) Represent the constituent societies of the Council in instances in which constituent societies deem such joint representation to be desirable.
(*c*) Administer on behalf of the engineering profession, those activities authorized by a majority of the constituent societies of the Council.

Article II

Membership

1 (*a*) The Council shall comprise representatives elected or appointed by the constituent societies. Each society having 15,000 or fewer members qualified to vote for national officers shall have one representative. Each society having more than 15,000 members qualified to vote for national officers shall designate one representative for each 10,000 such members or major fraction thereof. At the time of his election or appointment, each representative shall be a member of the governing board or an officer of the society which he represents.
(*b*) The President of each constituent society shall be ex-officio a member of Council and shall be expected to attend all meetings with all privileges except that of voting unless serving as an official alternate.
(*c*) Each constituent society shall elect or appoint from the membership of the governing board or from the officers one or more alternates, the number of alternates not to exceed the number of representatives on the Council. An alternate shall act as a member of the Council with full privileges when his principal is absent from Council meetings; when not substituting for an absent member, he shall have privileges without vote and shall be expected to attend all meetings of the Council.
(*d*) The representatives and alternates of constituent societies shall serve for the calendar year.

2 A national engineering society may become a constituent society of the Council upon proof that the qualifications required of its members classify them as constituting a generally recognized branch or group of the engineering profession and upon not less than a two-thirds affirmative vote of such constituent societies of the Council. Any member society of EJC may resign from membership upon a 90-day written notice to the secretary of EJC.

Article III

Officers

The officers of the Council shall be a president, a vice-president, a secretary, and a treasurer. Officers of the Council and their terms of office shall be determined in the following manner:

(*a*) The president of the Council shall be elected by the Council from the membership of the Council. The term of office of the president shall be one year and he shall assume office as of January 1 of each year.
(*b*) The vice-president of the Council shall be elected by the Council from among its membership, but must be representative of another constituent society than that represented by the President. The term of office of vice-president shall be one year and he shall assume office as of January 1.
(*c*) The secretary of the Council shall be selected and his term of office shall be as provided in the By-Laws.
(*d*) The treasurer of the Council shall be selected and his term of office shall be as provided in the By-Laws.

Article IV

Finances

1 The Council shall maintain a treasury into which shall be deposited all income received from any and all sources by the Council. Funds of the Council may be derived from any source approved by the Council including financial support by the constituent societies of the Council.
2 Financial support by the constituent societies shall be divided proportionately between said societies on the basis of dues income from members. For the purpose of determining the basis of such proportionate financial support the Council shall use from time to time, the ratio of dues income of constituent societies for their respective fiscal year last ended at the time of such determination.
3 Financial support by the constituent societies shall be for specific purposes or activities recommended by a majority of the Council. Any society not electing to contribute to any specific activity for which a part of such financial support is to be made shall not be required to participate in the cost of such part thereof; and, in such event, the ratio of financial support shall be revised in accordance with the dues income of the constituent societies participating in such specific activity.

Article V

Committees

1 *Executive Committee*—There shall be an Executive Committee consisting of the president of the Council as chairman, and representatives of four other societies, elected by the Council.

The Executive Committee shall be authorized to transact, during interim periods between Council meetings, any business consistent with established policy or procedure of the Council.
2 *Committee on Constitution and By-Laws*—The Council shall appoint a Committee on Constitution and By-Laws which shall study, report, and recommend with respect to revisions and amendments of the Council's Constitution and By-Laws.
3 *Other Committees*—The Council shall authorize and appoint all necessary committees to carry out the objectives of Council, utilizing members of constituent societies, and, in addition thereto, members of other societies of persons who are not engineers.

Article VI

Amendments

1 This Constitution may be amended by an affirmative vote of the governing boards of not less than two thirds of the constituent societies.

Article VII

Quorum

1 A majority of the membership of the Council, representing not less than two thirds of the constituent societies, shall constitute a quorum.

Adopted December 7, 1952

NOTE: As of December 7, 1952, the following are the constituent societies of Engineers Joint Council:

American Society of Civil Engineers
American Institute of Mining and Metallurgical Engineers
The American Society of Mechanical Engineers
American Institute of Electrical Engineers
American Institute of Chemical Engineers

Engineering Societies Personnel Service, Inc.

These items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members or not, and is operated on a nonprofit basis. In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office. When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th Street	84 East Randolph Street	100 Farnsworth Ave.	57 Post Street

Men Available[1]

Engineer-Manager, ME, MS in IE, textile engineer, desires position with future in management of medium-sized concern. Experienced in supervision and liaison between manufacturing and sales. Me-930.

Mechanical Engineer, 33, MSME, Sigma Xi, diversified experience in design, manufacturing, service large steam generators and other power-plant equipment. Also some experience in export sales and steamship management operations. Prefers eastern U. S. Me-931.

[1] All men listed hold some form of ASME membership.

General Manager, 37, five years' experience as manager of plumbing-ware plant. Full knowledge of production, finance, labor relations, accounting, engineering, etc. Graduate mechanical engineer. Desires management position. Me-932.

Mechanical Engineer, 37, BSME, 15 years of well-rounded experience in chemical-process-plant engineering, including equipment design, development, fabrication, and maintenance. Includes five years as engineer and chief draftsman with company manufacturing precision chemical equipment. Proved ability to organize and supervise. Desires responsible sales-engineering position. Me-933.

Management Engineer, 40, married, BS degree, 18 years' experience, administration, budget procedures, cost analysis, market analysis, general operational work, supervised plant-design construction, maintenance. Now selling heavy machinery overseas. Desires operating or sales work. Available, three months. Pacific Coast. Me-934-5211-D-4.

Mechanical Engineer, 31, BSME, BA. Ten years' experience in food industry, responsible for maintenance, construction, plant layout, budget control, including complete charge of all engineering problems for over 20 plants. Me-935.

Positions Available

Engineer, seven or eight years' engineering background, to handle design and redesign of new equipment and new machinery. Must be heavy on design and methods work. $8000. Long Island, N. Y. Y-7974.

Junior Executives, 27–37, experienced in machine-tool or heavy metalworking industry desirable. Will work closely with department head and with customers or suppliers in one of the following phases of the business: contract terms, delivery dates, scheduling of machine installation, and servicing repair parts. Purchasing and scheduling delivery of necessary electrical and hydraulic equipment initially, and later, patterns, rough materials, and all other supplies; supervising the development of better electrical controls for general-purpose machines; keeping up with new improvements and developments through close contact with electrical and hydraulic suppliers. Salary open. Northern Ill. Y-7984.

Engineers. (*a*) Chief product engineer, mechanical, minimum of 20 years' experience in engineering work, with special emphasis on the forging and machining experience. Will be responsible for the development of the manufacturing processes of new products, selection of the appropriate equipment, laying out the equipment, supervising the design of tools and auxiliary equipment. Should have good background in the aforementioned operations. Will supervise a group of 10 to 15 product engineers. $9000–$11,000 a year. (*b*) Research and development engineer, graduatee 15 to 20 years' experience in engineering work related to forging and machining operations. Will be responsible for conducting research in the development of new processes and new products in the same general type of work as the chief product engineer. $9000–$11,000. Y-7998.

Engineers. (*a*) Product engineer, graduat engineer, 15 years' experience in engineering work Will be assigned two to six draftsmen, design engineers, and tool engineers to investigate and work out details under the direction of the product engineer. Will be responsible for the development of the manufacturing processes for new products, selection of the appropriate equipment, laying out the equipment, supervising the design of tools and auxiliary equipment. $8000–$9500. (*b*) Tool engineer for the design and development of new or revised tools, dies, and accessories for any of the production equipment; will be concerned with the use and maintenance of tools to reduce costs and increase tool life. Will design the tooling for a wide variety of products (ordnance shells, ranging from 75 mm to 280 mm, large bombs, rockets, seamless pipe, steel pressure vessels, etc.). Should be a mechanical graduate. $7000–$8200. Pa. Y-7999.

Gear Design Engineer, experienced in the design and manufacture of small precision gears for aircraft instruments and actuators. $7000, and up. Mich. Y-8002.

Technical Writer, 25–35, for editorial staff of national industrial magazine. Should have engineering degree, preferably mechanical, experience in petroleum or chemical-manufacturing operations, and with emphasis on equipment. Must be able to write clearly and cleanly. Experience in magazine or newspaper field helpful, but not essential. Duties will include editing and rewriting copy, and field trips to gather data for original articles. Salary open. Ohio. Y-8005.

Assistant Chief Engineer, 35–50, American citizen, college graduate in engineering or science. Must be a good draftsman. Must have at least five years' experience on the board; and thorough knowledge of drafting-room practices and techniques. Must have at least ten years' design experience in metalworking manufacturing. This experience should cover both product design and tool design, with both large and small companies. Must have a thorough knowledge of tool design in heavy-metal stamping, production machining. General knowledge of foundry practice, forging, welding, heat-treating. $12,000–$15,000. Pa. Y-8017.

Assistant Director of Manufacturing and Chief Industrial Engineer, up to 45, for nationally known manufacturer of consumer products. Must be capable of supervising the activities of several large and modern plants. Will be responsible for a well-staffed industrial-engineering department. In addition to possessing practical experience and engineering training, must be qualified administrator. Salary open. Southeastern U. S. Y-8018.

Engineers. (*a*) Mechanical estimator, 30–45, graduate, considerable machine-shop background, and thorough knowledge of mechanical design and detailing as well as the capability of machine-tool operations. Must be able to estimate design and machine-shop time from his own sketch. Salary open. (*b*) Sales engineers, 28–38, qualified to sell gages and precision measuring equipment to the machine-tool industry. Should preferably be a graduate engineer, but applicant with background in precision inspection or machine-shop operations would qualify. Must be willing, after a period of training at the factory, to relocate in one of the district sales offices of the company. Salary open. Must be U. S. citizens. New England. Y-8022.

Tool Designer, up to 50, five years' experience in designing jigs, fixtures, and tooling for piercing, forming, and shearing operations. Will design tools, dies, jigs, and fixtures for metalworking on leaf springs, axles, and similar products for a manufacturer of automotive accessories. $6000–$7200. Pa. Y-8023-T-9465.

Operations Manager—Shipyard. Must have had previous experience in yards employing 2000 men or more, familiar with purchasing, outfitting ships, tests, and trials. $20,000–$25,000. New England. Y-8028.

Project Engineer, design, layout, field-survey, and estimating experience covering plumbing, heating, ventilating, air conditioning, and fire protection. $6500–$7800. Newark, N. J. Y-8029.

Production-Control Manager, 35–45, for medium-sized New England manufacturer of light-metal consumer goods. Multiplant setup. Will direct such an over-all program. Familiar with purchasing. $8000–$10,000. New England. Y-8046.

Plant Engineer, 30–40, preferably with mechanical degree and five to ten years' practical experience, including work of a project nature with full responsibility for the project. Experience in supervising the various building and ship trades, production people, and other engineers. Duties include development of plant layout and long-range plan for future expansion; engineering project work including investigation of various types of machinery available; design special equipment, etc. Salary open. Texas. Y-8051.

Industrial Engineer, IE degree, 30–40, preferably with electrical background, for field studies on maintenance, both preventive and repair, to establish procedures and costs. Some experience in maintenance procedures desirable, but not absolutely necessary. $7200. New York, N. Y. Y-8056.

Product-Development Engineer, mechanical or electrical degree, some knowledge of machine design as well as knowledge of business machines. Experience in electronics desirable. Knowledge of tools in the small metalworking field also desirable. $7500. New York State. Y-8063.

Secretary and Field Investigator for trade association dealing with compressed as well as manufactured and natural gases. $10,000. Considerable traveling. New York, N. Y. Y-8070.

Design Engineer, mechanical graduate, instrument and equipment experience for design and stress analysis on radar equipment. $5000–$6000. Newark, N. J. Y-8072.

Consultant to Production Department, experience and background in the production of small arms and ammunition such as fuses, shell cases, etc. $10,000. Mass. Y-8075.

Sales Manager, 40–45, mechanical or electrical graduate, at least ten years' supervisory sales experience covering temperature and pressure controls for heating-equipment field. $15,000. New York, N. Y. Y-8078.

Assistant Chief Mechanical-Design Engineer, graduate, five years' experience in mechanical design of large motors and generators, for one of the large electrical machinery builders. Should have broad knowledge of bearings, frame stresses, ventilation, etc. $7000–$9000. Ohio. Y-8079.

Manager, Engineering Research Division, 35–50, BS in EE, ME, or CE. Electromechanical and/or basic mechanical knowledge and experience essential. Knowledge of and experience in the design and use of machinery, equipment, and construction materials employed in the petroleum industry. Will administer and supervise the activities of the engineering research division, recommend improvements in plant and equipment design developed through investigation and research. Recommend improvement in basic engineering methods and techniques, etc. $16,000. Eastern Atlantic States. Y-8081.

Hydraulic Design Engineer, mechanical, at least three years' experience in design, product development or manufacturing pumps, and hydraulic equipment. Will assist chief engineer on project work in hydraulics department for manufacturer of pumps. Up to $9600. Employer will negotiate placement fee. Wis. T-9495.

Chief Engineer, up to 55, at least five years' experience in refrigeration design and application. Knowledge of low-side refrigeration. Will direct all engineering development and manufacturing of refrigerating equipment. Up to $10,000. Employer will pay placement fee. Ill. R-9472.

Chief Mechanical Engineer, up to 50, mechanical, at least five years' experience in design of of lawn mowers and small gasoline engines. Knowledge of production methods. Will be responsible for design and development of lawn mowers, engines, and accessories for a manufacturer. Up to $10,000. Employer may negotiate placement fee. Ill. R-9475(*b*).

Assistant Maintenance and Engineering Superintendent, mechanical engineer or equivalent, 30–40, two or three years' experience. Knowledge of motors, pumps, electrical wiring, heating boilers, building construction. Will assist maintenance and engineering superintendent in performance of duties including maintenance of office records and preparation of reports for paint manufacturer. $6000–$8000. Ill. R-9497.

Project Engineer, up to 45, at least three years' experience in metals and preferably shell casings, for manufacturer of sheet-metal products. Should have sheet-metal-shop background. Will do project work on sheet metal and shell casings. Must be U. S. citizen. $7200–$8400. Employer will negotiate placement fee. Ill. R-9512(*a*).

Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after Feb. 25, 1953, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member

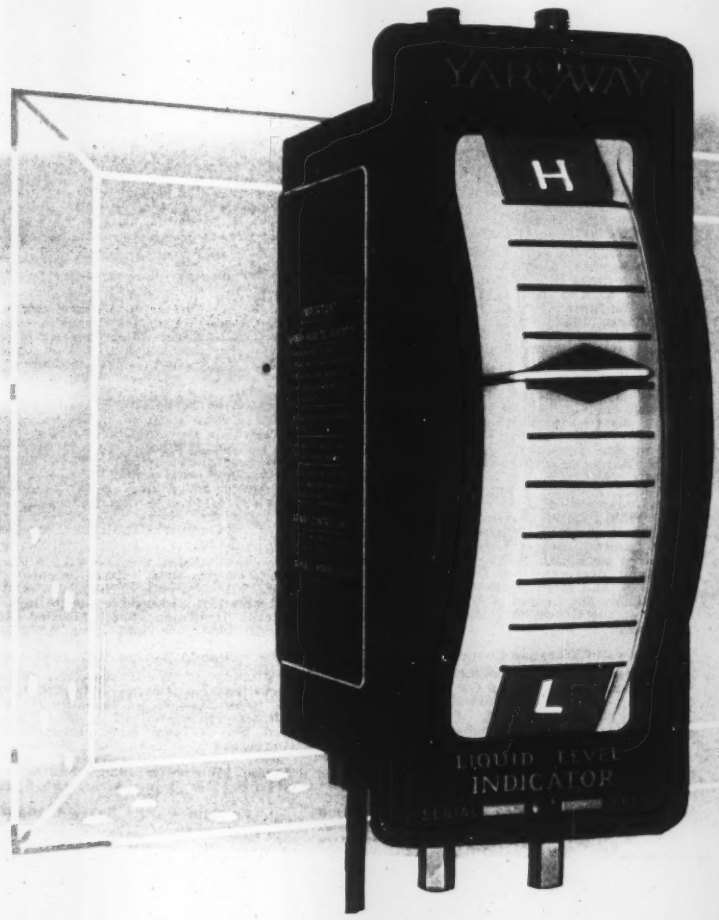
NEW APPLICATIONS

For Members, Associate, or Junior

ACSAI, JAMES A., Santa Clara, Calif.
AGREN, WALLACE J., Lincolnwood, Ill.
ANDERSON, ROBERT H., Philadelphia, Pa.
BAILEY, JOHN R., Baltimore, Md.
BAUDIS, LOUIS J., Fairfield, Conn.
BILLETER, JULIUS C., Salt Lake City, Utah (Rt)
BONIFAZI, ARTHUR W., Tulsa, Okla.
BONNER, CHARLES W., JR., Richmond, Va.
BOSSER, ROBERT P., JR., Columbus, Ohio
BRADSHAW, CLAYTON H., Cleveland, Ohio

(*ASME News continued on page 184*)

What's New
IN BOILER WATER LEVEL INDICATION?



Yarway Remote Liquid Level Indicator, manometric type, with automatic temperature compensation.

IMPROVED *WIDE VISION* REMOTE LIQUID LEVEL INDICATOR

A new-type face on the Yarway Remote Liquid Level Indicator now permits side as well as head-on dial readings. This vastly improved visibility makes it possible to check boiler water levels from most any position in the control room, or wherever the Yarway Remote Indicator may be installed.

MANOMETRIC TYPE

The Yarway Indicator is a manometric type with automatic temperature compensation. Level readings are instant and accurate because the indicator is operated by the boiler water itself. The indicating mechanism is never under pressure. There are no stuffing boxes.

Over 8,000 Yarway Remote Liquid Level Indicators are successfully operating throughout industry—primarily for indicating boiler water levels, but also for many other liquid level applications, and for superheater pressure differential indication aboard ship.

For full information on Yarway Indicators, write for Yarway Bulletin WG-1823.

YARNALL-WARING COMPANY • 108 Mermaid Avenue, Philadelphia 18, Penna.

YARWAY *STEAM PLANT EQUIPMENT*

BROWN, CHARLES T., Corpus Christi, Texas
BROWNE, GEORGE, New York, N. Y.
CALO, ARMAND G., Shrewsbury, Mass.
CARY, JOHN R., Livermore, Calif.
CASS, RICHARD W., South Gate, Calif. (Rt&T)
CHEQUER, HENRY, Jr., New Rochelle, N. Y.
CLARKE, RICHARD N., Troy, N. Y.
CRIM, WALTER R., Kansas City, Mo.
CRUMLEY, LEWIS W., Bridgman, Mich.
CRUMP, JOSEPH R., Houston, Texas
DANNER, RONALD F., Oklahoma City, Okla.
DAVIS, GEORGE C., Bound Brook, N. J.
DEAKIN, JOHN H., Cumberland, Md.
DEMARTINI, ROBERT J., Schenectady, N. Y.
DOSHER, RALPH T., Jr., Dallas, Texas
DUNLAP, HERSCHEL E., Salt Lake City, Utah
FAHRENBACH, WOLFGANG B., Oakland, Calif.
FINCH, DONALD I., Philadelphia, Pa.
FITZ, COLEMAN D., Excelsior, Minn.
FOLTZ, DAVID O., Detroit, Mich.
FRANKFURTER, ALROY E., Seattle, Wash.
FREEMAN, GORDON D., Midland, Mich.
FURLONG, THOMAS F., Martinsville, Va.
GASTPAR, JACQUES, Zurich, Switzerland
GILLIES, R. N., Victoria, Australia
GLOSS, EUGENE H., Springfield, Ohio
GOLDBECK, CARL W., Cleveland, Ohio
GOLDSMITH, ROBERT H., Williamsville, N. Y.
GONZALEZ, EDGAR, Milwaukee, Wis.
GRANT, WILLIAM J., Norfolk, Va.
GUDIKUNST, JAMES B., Ephrata, Pa.
HADLEY, WALTER C., Paget, Bermuda
HARKER, JOHN M., San José, Calif.
HATCH, CHESTER E., Jr., Greenville, S. C.
HATCHER, GROVER C., Jr., Plainfield, N. J.
HOISTAD, ARTHUR O., St. Paul, Minn.
HORNE, DONALD A., Dearborn, Mich.
JOHNSEN, ARTHUR P., Toronto, Ont., Can.
JOHNSON, RUPERT P., Houston, Texas
KANN, MYRON, Gardena, Calif.
KERBY, ABNER B., Jr., Leighton, Ala.
KILGOUR, JOHN A., Prospect Park, N. J.
LAROCCO, JOSEPH, Torrington, Conn.
LAWRENCE, JOSEPH M., Omaha, Neb.
LEFOR, FRANK M., Forest Hills, N. Y.
LUCE, JOHN W., Charleston, W. Va.
MCGIBBON, C. M., New Glasgow, N. S., Can.
MCMULLEN, JOHN J., Chevy Chase, Md.
NESTERIAK, PAUL G., Shelton, Conn.
NEUMANN, ALBERT M., Charleston, W. Va.
PAGE, JAMES, Detroit, Mich.
PONKSHE, HARI D., Detroit, Mich.
POWERS, JACK D., Duluth, Minn.
PRICE, JOHN F., Glen Ridge, N. J.
QUERREJETA, ALBERTO C., Havana, Cuba
REDNA, THEODORE, Akron, Ohio
REED, HARVEY E., Newark, N. J. (RT&T)
ROSENDALE, ROBERT M., Mt. Carmel, Pa.
SAATHOFF, GEORGE T., New York, N. Y.
SACHS, DONALD J., Detroit, Mich.
SCHELL, WILLIAM J., Jr., Melrose, Mass.
SCOTT, HOWARD J., Cleveland, Ohio
SELLERS, HUGH L., Jr., Kinston, N. C.
SHUTKO, FRANK W., Trenton, Mich. (RT&T)
SIRIEX, JEAN A., Paris, France
STEINMILLER, WILLIAM G., Philadelphia, Pa.
STEPHANAKIS, MICHAEL J., Wichita, Kan.
STEWART, GENE, Bedford, Ohio
STREET, BUFORD B., Chattanooga, Tenn.
SURMACZ, JOSEPH G., Milwaukee, Wis.
SWAN, DAVID E., Tampa, Fla.
TELFER, JOHN C., Rochester, N. Y.
TERHUNE, QUENTIN E., New York, N. Y.
UMEDA, JOE, Sacramento, Calif.
VECKRA, PAUL D., Bourbonnais, Ill.
VERVERELLI, DIMITRI J., Yeadon, Pa.
WARDLAW, RUSSELL, San Francisco, Calif.
WEINGARTEN, VICTOR, New York, N. Y.
WIESEMANN, VALENTIN G., Hannover, Germany
ZLATIN, NORMAN, Cincinnati, Ohio (RT&T)

CHANGE IN GRADING

Transfers to Member and Associate

BAHN, GILBERT S., Schenectady, N. Y.
BARTA, GEORGE L., Jr., Little Neck, N. Y.
BLACK, WILLIAM T., Evergreen Park, Ill.
BREYMEIER, R. THOMAS, Niagara Falls, N. Y.
BROOKS, CHARLES W., Stamford, Conn.
CAMPBELL, CLARENCE B., Swarthmore, Pa.
CAMPBELL, HOWARD E., Des Moines, Iowa
CHURCHILL, LAWRENCE S., Jr., Louisville, Ky.
CRYOR, DONALD P., Glenolden, Pa.
DOUGLASS, MALCOLM E., West Lynn, Mass.
GOODWIN, JOHN H., San Francisco, Calif.
GORDON, ARTHUR, Linden, N. J.
HORNER, JOHN S., Dollar Bay, Mich.
JENSEN, JOSEPH W., Cedar Rapids, Iowa
LLANSO, JOAQUIN J., Springfield, N. J.
MALCOLM, DONALD G., Berkeley, Calif.
MARCOTTE, ROBERT L., Rochester, N. Y.
MCALISTER, ANDERSON O., Wilmington, Del.
MCCLURE, ARTHUR W., Milwaukee, Wis.
MCKAY, GORDON B., Ramsey, N. J.
MILLER, DURBEN E., Monroe, La.
MILLER, FRANK W., Laverock, Pa.
MIRRER, RAYMOND, Forest Hills, N. Y.
MOEN, WALTER B., Berkeley Heights, N. J.
MUNSCHAUER, FREDERICK E., Jr., Buffalo, N. Y.
NASH, WILLIAM A., Washington, D. C.
NEALE, ABAB B., Los Angeles, Calif.
POHL, RICHARD G., Mercer Island, Wash.
RAPP, EDWARD G., Cleveland, Ohio
REAMY, VINCENT J., London, England
RISE, KAARE, Wilmington, Del.
ROTHCHILD, OSCAR A., Evanston, Ill.
SERVICE, ROBERT R., Willowdale, Ont., Can.
WAYNE, HARRY B., Brooklyn, N. Y.
YATES, MAX E., Richland, Wash.
ZIETLOW, FRED P., Indianapolis, Ind.

Transfers From Student Member to Junior....62

Obituaries

Walter Stanley Bryde (1886–1952?)

WALTER S. BRYDE of the National Production Authority, General Industrial Equipment Division, U. S. Government, Washington, D. C., died recently, according to a report received by the Society. Born, New York, N. Y., March 18, 1886. Education, ME, Cornell University, 1909. Mem. ASME, 1950.

Charles Thomas Clark (1898–1952)

CHARLES T. CLARK, engineer, C. F. Braun & Co., Alhambra, Calif., died Nov., 22, 1952. Born, Chicago, Ill., March 23, 1898. Parents, Thomas A. and Effie Clark. Education, BS (ME), Tri-State College, 1924. Married Alice M. Adams, 1922. Mem. ASME, 1949. Survived by wife; daughter, Mrs. Gloria J. Offenhauser; and three grandchildren.

Wat Tyler Cluverius (1874–1952)

WAT T. CLUVERIUS, Rear Admiral, USN, retired; one of the last survivors of the USS Maine disaster, in Havana Harbor, 1898, and president of Worcester Polytechnic Institute, died in New Haven (Conn.) Hospital, Oct., 28, 1952. Born, New Orleans, La., Dec. 25, 1874. Parents, Wat T. and Martha L. (Manning) Cluverius. Education, BS, U. S. Naval Academy, 1896. Married Hannah W. Sampson, 1900 (died 1938); children, Elisabeth S. C. Crenshaw, Martha C. Parsons, Wat T., Jr. Mem. ASME, 1940. During his career many honors were conferred upon him. He received eight honorary academic degrees; the Distinguished Service Medal of the United States, the Order of Leopold of Belgium, the Legion of Honor of France, the Order of the Crown of Italy, and the Order of St. Olav of Norway.

Howell Carnaghan Cooper (1874–1952)

HOWELL C. COOPER, engineer, retired in 1939 as president, Hope Natural Gas Co., died Oct. 27, 1952, at his home in Sewickley, Pa. Born, Oil City, Pa., Feb. 26, 1874. Parents, Charles E. and Britta Morgan (Carnaghan) Cooper. Education, high-school graduate; special instruction in mathematics and engineering. Married Annetta C. Heissenbuttal. He received the Charles A. Monroe Award from the American Gas Association, 1938. In 1940 the International Petroleum Exposition awarded a medal in recognition of his long service to the oil and gas industries. Mem. ASME, 1912. Survived by wife and two children, Mrs. Mary Cooper Robb and Charles W. Cooper, New Canaan, Conn.

Harvey Nathaniel Davis (1881–1952)

HARVEY N. DAVIS, president emeritus of Stevens Institute of Technology and for 23 years its president until his retirement in 1951, died Dec. 3, 1952. Born, Providence, R. I., June 6, 1881. Parents, Nathaniel F. and Lydia M. (Bellows) Davis. Education, AB, Brown University, 1901; AM, 1902; AM, Harvard University, 1903; PhD, 1906; honorary degrees, LLD, Rutgers University, 1928; DS, Brown University, 1928; DE, New York University, 1936; DE, Rose Polytechnic Institute, 1938; DS, Northeastern University, 1938; DS, Columbia University, 1940. Married Suzanne C. Haskel, 1911 (died 1919). Married 2nd, Alice M. Rohde, 1920 (died 1933). Married 3rd, Helen Clarkson Miller, 1935. In World War I he did research work on helium gas for the Army, Navy, and the Bureau of Mines. He headed the Office of Production Research and Development in 1942. The following year he led a mission to London to establish closer liaison with British research and production authorities. Soon thereafter he was made an honorary member of The (British) Institution of Mechanical Engineers, the fourth American so honored. His principal field of research was thermodynamics, particularly relating to steam tables. His inventions included an improvement in steam turbines and processes for air liquefaction and rectification. He wrote textbooks and scientific papers on thermodynamics. Mem. ASME, 1920; Fellow ASME, 1936; Hon. Mem. ASME, 1947. He served the Society as vice-president, 1930–1932; president, 1937–1938. He was an honorary member of The Franklin Institute. Survived by his wife; a son, Nathaniel Davis of the United States Consulate in Rome, and three daughters: Mrs. Robert S. Way, Bellmore, N. Y.; Mrs. Bliss Woodruff, Hamden, Conn.; and Miss Louise Davis, Hoboken, N. J.

Alpheus Penn Denton (1880–1952)

A. PENN DENTON, consulting engineer, Tucson, Ariz., died July 10, 1952. Born, Downs, Kan., May 10, 1880. Education, ME(EE), Cornell University, 1904. Married Elizabeth Knapp, 1908; children, Dorothy, Elizabeth, Saradora, Mary Priscilla. He was recipient of the McGraw Hill Award for outstanding work as an electrical contractor in the field of electrical safety standards. Mem. ASME, 1926.

William Sebastian Graff-Baker (1889–1952)

WILLIAM S. GRAFF-BAKER, chief mechanical engineer (railways), LPTB., and Acton Works, London (England) Transport Executive, died Feb. 15, 1952. Born, Baltimore, Md., Nov. 14, 1889. Education, Cleobury Mortimer College, England; BS(Eng) EE, City and Guilds of London Central Technical College (ACGI Diploma). Naturalized British subject. Mem. ASME, 1948. Held several patents on electric-railway rolling-stock design, construction, and operation. Survived by wife, Eve.

Thomas William Greene (1895–1952)

THOMAS W. GREENE, development engineer, Linde Air Products Division, Union Carbide and Carbon Corp., New York, N. Y., died Nov. 27, 1952. Born, Bloomington, Ind., Oct. 2, 1895. Parents, William O. and Agnes (Burke) Greene. Education, AB, Indiana University, 1917. Married Laura Cain, 1924. He had invented several improvements related to welding, having previously worked on oxyacetylene welding and cutting problems and other welding research and development as well as on the Unionmelt welding process. Author of several published technical papers. Mem. ASME, 1927. Survived by wife; a son, Thomas W., Jr., and two daughters, Mary Mildred and Laura; his mother and a sister, Miss Margaret Greene.

Russell R. Haldeman (1907–1952)

RUSSELL R. HALDEMAN, experimental engineer, De Laval Steam Turbine Co., Trenton, N. J., died Oct. 18, 1952. Born, Scranton Pa., Sept. 29, 1907. Parents, George E. and Dorothy (Martindale) Haldeman. Education, BS(ME), Drexel Institute, 1933. Married Mildred L. Riegel, 1934; one child. Jun. ASME, 1933.

Robert Benson Hall (1903–1952)

ROBERT B. HALL, manager, foreign manufacturing department, Corn Products Refining Co., New York, N. Y., died July 21, 1952. Born, Chicago, Ill., April 29, 1903. Parents, F. B. and May (Fluke) Hall. Education, BS(ME), University of Illinois, 1925; Advanced Management, Harvard University, 1946. Married Evelyn Manchester, 1933; children, Franklin E., John B., Mary Lou. Mem. ASME, 1947.

Franklin William Hazzard (1921–1952)

FRANKLIN W. HAZZARD, district sales engineer, Haveg Corp., Newark, Del., died at his home in Atlanta, Ga., Oct. 26, 1952. Born, Philadelphia, Pa., July 31, 1921. Parents, John B. and Agnes (Lacey) Hazzard. Education, BME, University of Delaware, 1948. Married Thelma Townsend, 1941; children, Barbara L., Nancy J. Jun. ASME, 1948.

Halvor Olsen Hem (1863–1952)

HALVOR O. HEM, former chief engineer, Toledo Scale Co.; an inventor, collector, and maker of unusual clocks, died Nov. 11, 1952. Born, Saude, Norway, Aug. 14, 1863. Education, eight years, common school; hon. DS, University of Toledo, 1936. He held more than 150 patents in the United States and abroad. In 1932 he received the John Price Wetherill Medal from The Franklin Institute for outstanding work in perfecting scales of the pendulum type. He was the designer of most of the wind-tunnel measuring systems of the United States, Russia, and Sweden. Mem. ASME, 1909; Fellow ASME, 1950.

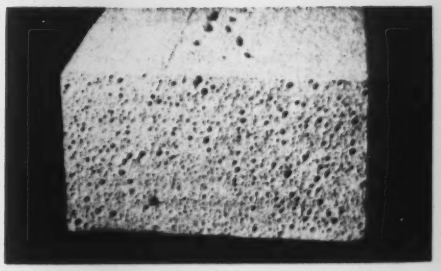
Raymond Samuel Jolley (1900–1952)

RAYMOND S. JOLLEY, mechanical and combustion engineer, Consolidated Water Power and Paper Co., Wisconsin Rapids, Wis., died Oct. 16, 1952, at his home in Plover, Wis. Born, Hulett, Wyo., Jan. 6, 1900. Education, 5½ years, B. H. Teachers College; BS(ME), University of Nebraska, 1928. Mem. ASME, 1951. He was the author of several papers published in technical journals and held patents on fly-ash recovery method for cyclone furnaces, toolpost grinders, stoker tuyères, and a combination lathe toolpost and boring bar holder.

(ASME News continued on page 186)

Striking evidence of this refractory's insulating ability: Though one end of the brick is incandescent—having been heated to over 2000 F—the other end is held *in the bare hand.*

"Bubble-brick" insulates at over 3000 F



How an ALFRAX BI brick looks when cut through with a diamond wheel. This discloses the thousands of voids formed by the hollow fused-alumina "bubbles."

Here is one of the most heat-resistant refractories available. And one of the most stable. It shows very little shrinkage, or other changes — *even at maximum burning temperatures of most fuels!* It stands higher heats (has a P.C.E. value 39-40, equivalent to 3389-3425 F), and greater loads than previously possible with low heat capacity refractories.

ALFRAX BI refractories are literally made of bubbles; hollow spheres of Al_2O_3 specially bonded together. They are light in weight (a 9″ straight weighs only 4.8 lbs.); have low thermal conductivity (average 7 Btu/hr. sq ft and °F/in. of thickness at 2200 F); and therefore have low heat capacity. They are also one of the most inert materials known. They are unaffected by furnace atmospheres, or combustion gases of commercial fuels.

These "bubble-brick", as they are sometimes called, are used in main linings as sidewalls, arches, doors, etc. and also for backing-up linings. They are used in many types of furnaces (e.g. powdered metallurgy furnaces, aluminum reverberatory furnaces, ceramic kilns, synthesis gas generators). The advantages are: longer refractory life, closer heat control, and a furnace that heats up quicker and needs less fuel.

ALFRAX BI refractory is available as brick, special shapes, standard cements, and as a *castable* cement that you just mix with water and pour. For information about the properties of this and other unusual super refractories by CARBORUNDUM just mail this coupon.

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The Carborundum Company,
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Albert I. Jones (1863–1952)

ALBERT I. JONES, general manager, Pfaudler Co., Rochester, N. Y., for 45 years, and a former director of the firm, died Oct. 28, 1952. Born, Port Sarnia, Ont., Can., Aug. 24, 1863. Education, attended Cornell University, 1886–1887. While he was not responsible for the design of the company's products, he did design some of the complicated machine tools and devised production methods instrumental in their production. Mem. ASME, 1892. Survived by his wife, Laurieta Woodbury Jones; a daughter, Mrs. Adrian L. Spencer; a son, F. Woodbury Jones; and a granddaughter.

Dexter Simpson Kimball (1865–1952)

DEXTER S. KIMBALL, dean of the Cornell University college of engineering for 16 years until he retired in 1936, and a specialist in industrial engineering and management problems, died Nov. 1, 1952. Born, New River, New Brunswick, Can., Oct. 21, 1865. Parents, William H. and Jane (Paterson) Kimball. Education, BA (in engineering), Stanford University, 1896; ME, 1913; honorary degrees, LLD, University of Rochester, 1926; DS, Case School of Applied Science, 1930; DE, Kansas State College, 1933; Northeastern University, 1934; Lehigh University, 1939. Married Clara Evelyn Woolner, 1898; children, Isabella Jane, Dexter S., Jr., Mem. ASME, George N. Appointed by Secretary of Commerce Hoover as chairman of the Organizing Committee, Second Pan-American Standardization Conference, 1927; chairman, Priority Committee on Machine Tools and Equipment, OPM, 1941; chief of priority section, Machine Tool Division, War Production Board, 1942–1943. Member of the Society for the Promotion of Engineering Education (vice-president, 1922–1923; president, 1929). Mem. ASME, 1900; Fellow ASME, 1936; Hon. Mem. ASME, 1939. He was president of ASME, 1921, after having served as manager from 1919 to 1921. He was president of the American Engineering Council, 1926–1928. Received the SPEE Lamme Medal, 1933; ASME Worcester Reed Warner Gold Medal, 1933; AMA–ASME H. L. Gantt Gold Medal, 1943; SAM Fred Winslow Taylor Key, 1948. He was the author of several technical books; editor, The Book of Popular Science; contributed to the scientific press.

Thurs Lars Ferdinand Larsson (1865–1952)

THURS L. F. LARSSON, whose death was recently reported to the Society, was until his retirement in 1941, a mechanical engineer, Norton Co., Worcester, Mass. Born, Sweden, Dec. 4, 1865. Parents, Lars G. and Eugenia H. Larsson. Education, graduate, Swedish High School, 1884; attended Uppsala University, 1885–1886. Naturalized U. S. citizen Worcester, Mass., Oct. 3, 1905. Married Emma C. Fladquist, 1894; children, Helen E., Ralph T. He received the Modern Pioneer Award from the National Association of Manufacturers. Mem. ASME, 1905.

William Leo Lundy (1895–1952)

WILLIAM L. LUNDY, whose death was recently reported to the Society, was staff steam engineer, Kimberly-Clark Corp., Neenah, Wis. Born, Taylorsville, Ill., Dec. 9, 1895. Parents, James and Josephine Lundy. Education, BS(ChE), Purdue University, 1917. Married Nelle M. Miller, 1922; children, Lawrence J., William L., Jr. Jun. ASME 1920; Assoc-Mem. ASME, 1925; Mem. ASME, 1935.

Thomas Francis Lynch (1894–1949?)

THOMAS F. LYNCH, who died three years ago according to a report recently received by the Society, was chief engineer, Andes Copper Mining Co., Santiago, Chile, S. A. Born, Susquehanna, Pa., June 25, 1894. Education, graduate, Laurel Hill High School, 1911; Erie RR Machinist Apprentice Technical School, 1915; American Correspondence School; University of Minnesota Extension Courses. Jun. ASME, 1945; Mem. ASME, 1947.

Paul Beagary Morgan (1869–1952)

PAUL B. MORGAN, chairman of the board, Morgan Construction Co., Worcester, Mass., died Nov. 3, 1952. Born, Worcester Mass., May 7, 1869. Parents, Charles H. and Rebecca Ann (Beagary) Morgan. Education, BS, Worcester Polytechnic Institute, 1890; postgraduate study, Royal School of Mines, Stockholm, Sweden, 1891. Married Lessie L. Maynard, 1893 (died 1940). He received an honorary DE degree from Worcester Polytechnic Institute, 1929. Jun. ASME, 1891; Mem. ASME, 1900. Survived by four sons, Philip M., president of Morgan Construction Co.; Paul B., Jr., its treasurer; Dr. Charles Hill Morgan, professor of archaeology, Amherst College; and Prof. Vincent Morgan, music instructor, Amherst; a daughter, Mrs. Kenneth D. Robertson, Concord, Mass.; 13 grandchildren and seven great-grandchildren.

Edmund Brush Neil (1890–1952)

EDMUND B. NEIL, consulting engineer, Columbus, Ohio, died Aug. 30, 1952. Born, Columbus, Ohio, Oct. 10, 1890. Parents, David B. and Ellen Peabody (Brush) Neil. Education, BME, Ohio State University, 1915; ME, 1928. Married G. Eloise Foote, 1916; children, Judith V., Adelaide B. He was author of several hundred published articles in various technical magazines covering such fields as automotive engineering, manufacturing, research, advertising, and management. Jun. ASME, 1915; Assoc-Mem. ASME, 1920; Mem. ASME, 1928. Served the Society as a member of the Subcommittee on Drafting Practices (Dimensioning).

Joseph Paul Van Hook (1927–1952)

JOSEPH P. VAN HOOK, who had been a student engineer with The Babcock & Wilcox Co., New York, N. Y., was killed in Austria, Sept. 1, 1952, while in the Service. Born, Paterson, N. J., Dec. 13, 1927. Parents, Joseph F. and Julia (Hemschoot) Van Hook. Education, ME, Stevens Institute of Technology, 1949. Jun. ASME, 1949. Survived by mother; brother, Frater Brennan Van Hook, Washington, D. C.; two sisters, Mrs. Margaret Lanchantin, Leonia, N. J.; Miss Frances Van Hook.

Arthur Herbert Woodward (1870–1952?)

ARTHUR H. WOODWARD, whose death was recently reported to the Society, was president, International Register Co., Chicago, Ill. Born, Chicago, Ill., Oct. 27, 1870. Parents, James L. and Hannah G. (White) Woodward. Education, ME, Cornell University, 1892. Married Edith M. Norton, 1896 (deceased); children, Julian L., Elinor M. (Mrs. Ansel M. Kinney); Herbert N. He held patents on fare and coin registers, checkwriters, combination locks, cutting machines, meters for selling refrigerators, double-decker sleeping cars, vending machines, and the Universal wind vane sight for airplane machine guns. Mem. ASME, 1913.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult reverse side of card for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting your address, business connection, and Professional Divisions enrollment is printed on this page. Please use it to keep the master file up to date.

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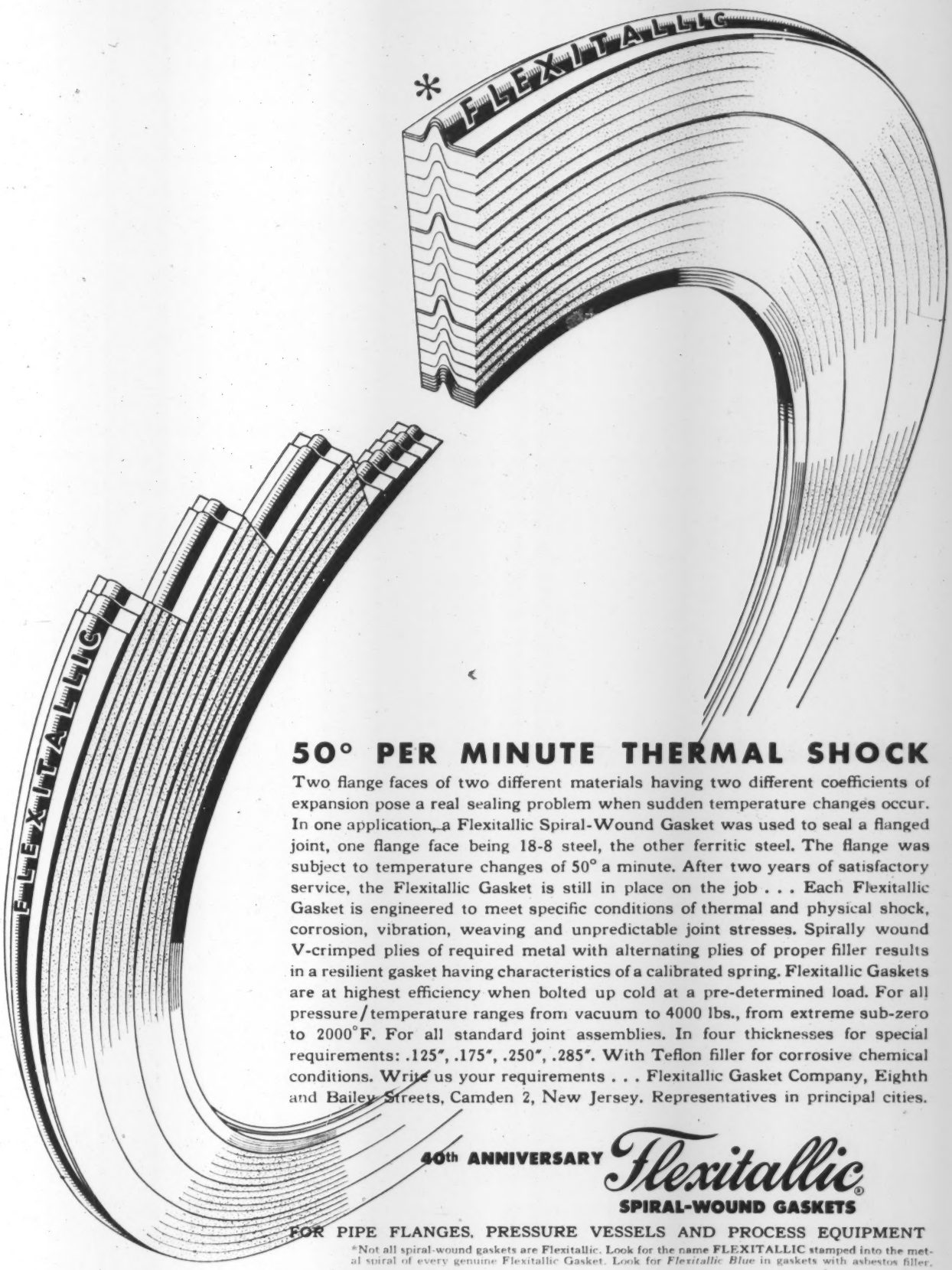

50° PER MINUTE THERMAL SHOCK

Two flange faces of two different materials having two different coefficients of expansion pose a real sealing problem when sudden temperature changes occur. In one application, a Flexitallic Spiral-Wound Gasket was used to seal a flanged joint, one flange face being 18-8 steel, the other ferritic steel. The flange was subject to temperature changes of 50° a minute. After two years of satisfactory service, the Flexitallic Gasket is still in place on the job . . . Each Flexitallic Gasket is engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses. Spirally wound V-crimped plies of required metal with alternating plies of proper filler results in a resilient gasket having characteristics of a calibrated spring. Flexitallic Gaskets are at highest efficiency when bolted up cold at a pre-determined load. For all pressure/temperature ranges from vacuum to 4000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285". With Teflon filler for corrosive chemical conditions. Write us your requirements . . . Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey. Representatives in principal cities.

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JENKINS PRACTICAL PIPING LAYOUTS 65

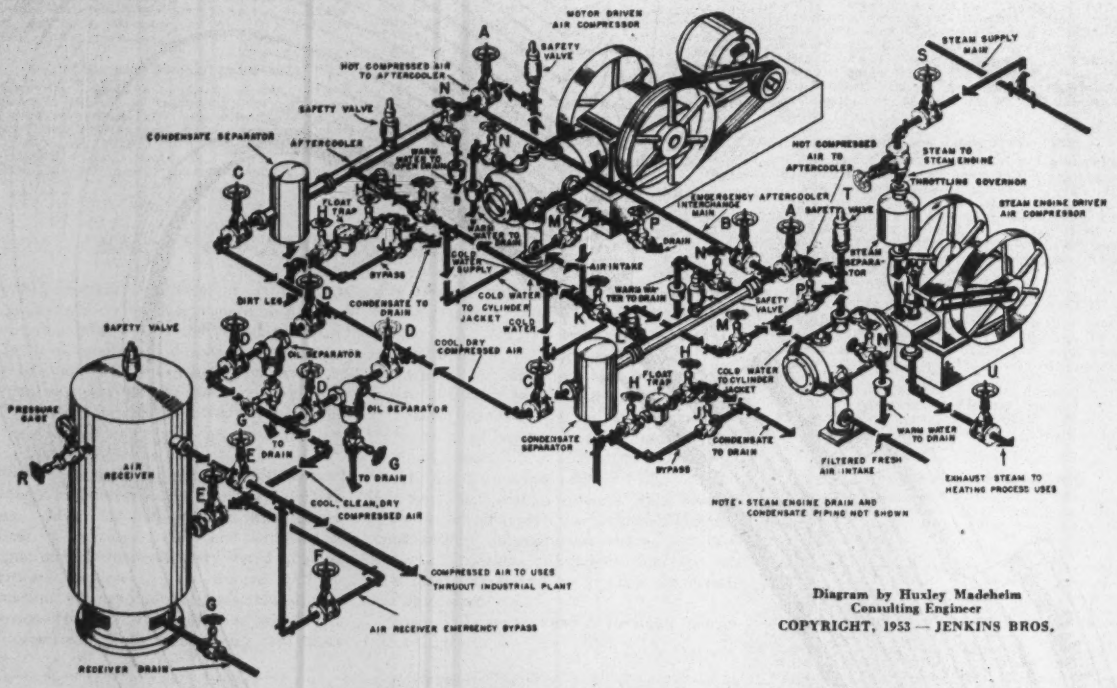

Diagram by Huxley Madeheim
Consulting Engineer
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VALVE RECOMMENDATIONS
Send for details of Jenkins Valves to suit varying conditions.

Code	Quan.	Jenkins Valves	Service
A	2	Fig. 651-A I.B.B.M. Gate	Compression Discharge Shutoff
B	1	Fig. 651-A I.B.B.M. Gate	Emergency Changeover Line
C	2	Fig. 651-A I.B.B.M. Gate	After Cooler Shutoff
D	4	Fig. 651-A I.B.B.M. Gate	Oil Separator Shutoff
E	2	Fig. 651-A I.B.B.M. Gate	Air Receiver Shutoff
F	1	Fig. 651-A I.B.B.M. Gate	Air Receiver Shutoff
G	3	Fig. 106-A Bronze Globe	Drain Line
H	4	Fig. 950 Bronze Globe	Trap Shutoff
J	2	Fig. 950 Bronze Globe	Trap By Pass
K	2	Fig. 106-A Bronze Globe	Cold Water Control
L	2	Fig. 352 Swing Check	Prevent Backflow
M	2	Fig. 106-A Bronze Globe	Cold Water Control
N	4	Fig. 106-A Bronze Globe	Drain Shutoff
P	2	Fig. 106-A Bronze Globe	Drain Shutoff
R	1	Fig. 744-G Needle Angle	Pressure Gage Control
S	1	Fig. 204 I.B.B.M. Gate	Steam Supply Line
T	1	Fig. 923 I.B.B.M. Globe	Steam Engine Shutoff
U	1	Fig. 651-A I.B.B.M. Gate	Engine Exhaust Shutoff

How to plan PIPING CONNECTIONS FOR AN INDUSTRIAL PLANT AIR COMPRESSOR

Compressed air is more economically supplied from a central installation in plants where demand is extensive. In such a system, the highest single pressure requirement in the plant determines the number of compression stages needed, and local pressure reducing stations meet the requirements of specific operations.

A single stage system is shown in this layout. Equipped with electric and steam driven compressors, this installation can develop 125 p.s.i. The former usually serves as a stand-by unit, but both can be used jointly for heavy load conditions.

The compressed air, after leaving the compressors, passes through a water-cooled after-cooler, which lowers air temperature and condenses moisture. The air then goes through oil separators and on into the air receiver, which decreases pressure pulsations and serves as a storage reservoir.

A capacity reduction device helps control load fluctuations in the constant-speed electrically driven compressor. In variable speed steam driven compressors, the throttling governor responds to load changes.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of lowest cost in the long run. Jenkins Bros., 100 Park Ave., New York 17.

Complete description and enlarged diagram of this layout free on request. Includes additional detailed information. Simply ask for Piping Layout No. 65.

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VALVES
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ANNOUNCEMENTS OBTAINED MOSTLY FROM ADVERTISERS IN MECHANICAL ENGINEERING AND ASME MECHANICAL CATALOG

New Equipment *Business Notes* *Latest Catalogs*

Available literature or information may be secured by writing direct to the manufacturer and mentioning MECHANICAL ENGINEERING as a source.

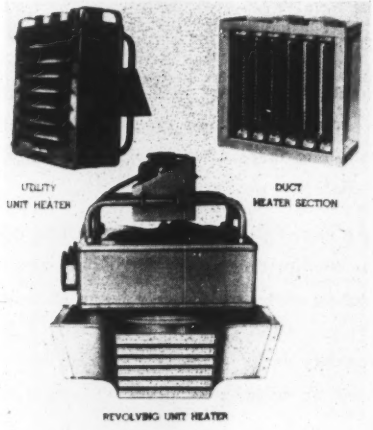
New Equipment

Electric Unit Heaters

L. J. Wing Mfg. Co., Linden, N. J., announces a new line of unit heaters and heater sections, incorporating electric heating elements, and designed for applications where steam, hot water, or gas is not available or economical to use.

The Wing electric heaters employ the Hynes electric heating element; one feature being a unique patented arrangement of flexibly mounted insulators suitable for the hardest kind of service up to 6000 volts.

These electric heaters are available in a wide range of sizes, the unit heaters delivering from 13,600 Btu per hr to 204,000 Btu and the heater sections from 25,500 Btu per hr to 204,000 Btu per hr. The smallest unit discharges at the rate of 235 cfm and the largest at 3600 cfm.



Three types of unit heaters are available: (1) an electric ceiling-suspended, downward discharge heater with revolving discharge outlets for all buildings or rooms where personnel are at work. (2) an electric ceiling-suspended, downward discharge heater with stationary discharge outlets, for storage sections, garages, loading docks, etc. and, (3) an electric horizontal discharge heater with adjustable vanes, for use at relay stations, pump houses, crane cabs, watchmen's shanties, and other locations where steam lines are not feasible. In summer, with the heating element switched off and the fan on, the electric heaters can be used as cooling systems.

The Wing duct heater sections are designed to be applied to a run of duct, for process heating or replacing exhausted air with fresh tempered air, where steam or hot water is not available or economical.

Rack Mounting Adapter

A new rack mounting adapter for use with Du Mont Types 303, 303-A, 303-AH, and 322 cathode-ray oscillographs is now available from the Instrument Div., Allen B. Du Mont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. The adapter is designated as the type 2598.

The adapter has been designed to provide a rigid mount for the instrument and to present a neat, yet completely accessible unit in standard 19-in. relay racks. The type 2598 bolts to the rack frame and provides a sufficiently large front opening to permit all but the front panel of the cathode-ray oscillograph to pass through. Channels are fastened to the type 2598 adapter to provide support for the instrument. Provision has also been made for the bolting of the instrument cabinet to these channels so that the entire relay rack may be moved with the instrument in place.

New Flo-Watch Model

Builders-Providence, Inc., one of the B-I-F Industries, Providence, R. I., has introduced a new Flo-Watch model (AFUAQ) for metering flow of liquids, steam, air, and gas. Flo-Watch measures the flow through standard differential producers such as Venturi tubes, nozzles, and orifices, also, it is designed for use with Kennison open nozzles, flumes, weirs. This instrument is adaptable for any combination of totalizing, indicating, or recording functions.

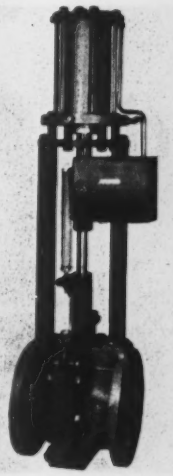
A totalizing model with transmitter attachment can actuate a secondary instrument or pace a chemical feeder remotely located. The functions of the secondary unit will be in direct proportion to flow. A summation meter also may be operated from simple transmitting attachments in several individual Flo-Watch instruments to summate the flow readings of a number of meters. Only electrical connections are required from the Flo-Watch transmitter, thus allowing the summation unit to be located wherever convenient.

The AFUAQ is an extension of Builders line of "Flo-Watch" instruments. It provides the high accuracy and dependability of the Flo-Watch at lower cost for those applications having a narrow flow range. The totalizer reads directly in quantity units such as gallons or cubic feet, and the indicator scale and chart graduations are carefully arranged to provide maximum readability throughout the measuring range from 25% to 100% of full scale.

Poweractor Positioner

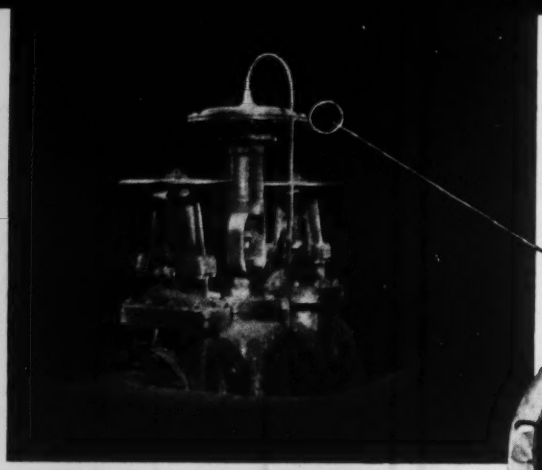
Accurate positioning of cylinder-operated devices is the function of the new Poweractor positioner, introduced by the Foxboro Co. Foxboro, Mass. Operating from a standard 3 to 15-psi pneumatic controller signal, it applies a high-pressure, pneumatic differential across a cylinder piston, sufficient to produce the position demanded by the controller.

Designed especially for use with the Foxboro Stabiload cylinder the Poweractor unit will position equipment requiring long stroke and power, such as large-size control valves, dampers, variable-speed drives, Saunders and Pulp Stock valves, through pneumatic cylinder (or springless diaphragm) operating mechanisms.



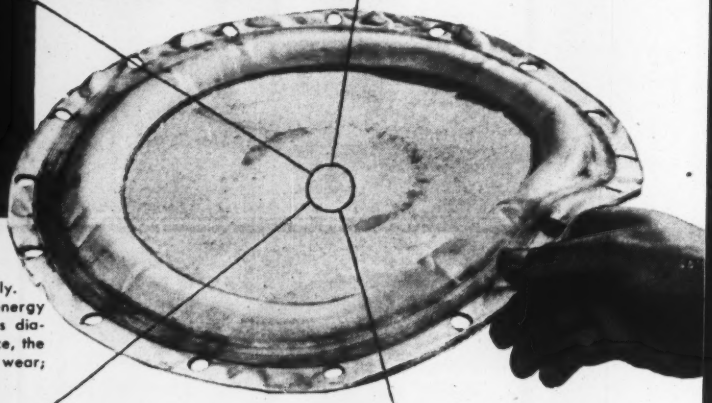
The Poweractor positioner is a force balance type instrument, connected to the cylinder piston rod through a bracket and spring assembly. Every change in the controller signal produces a corresponding position change of the piston, and the positioner automatically returns to a null balanced condition.

Powerful and fast, the Poweractor positioner is capable of handling up to 150 psig air supply, depending upon cylinder rating, and delivers, for example 12 scfm air flow with a 50 psig supply. It responds to a change in signal pressure of 1/4 of 1% of range and positions a piston within 1% of its total stroke under normal loading conditions. Direction of piston movement with respect to a signal pressure may be reversed by simply inverting the positioner. Component parts are enclosed in a weatherproof case, measuring 6 × 7 1/4 × 3 5/8 in.. Air connections are 1/4 in. NPT.



The diaphragm in this valve that regulates the intake to a boiler feedwater storage tank, is in almost constant motion 24 hours a day at temperatures well above 100°F. Successive synthetic rubber diaphragms lasted 7, 11 and 13 months respectively. That's unsatisfactory performance in a power house supplying energy to a large chemical plant. So they tried a Silastic coated glass diaphragm. Recently inspected after more than 78 months of service, the Silastic diaphragm was still soft and flexible; showed little wear; appeared serviceable for many more months.

As a valve diaphragm at +100°F SILASTIC outlasts heat-stable organic rubber 7 to 1



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And Silastic is in a class by itself among rubbery materials. For example, we have aged typical samples of a Silastic stock for 12 months in an air circulating oven at 350°F. After such accelerated aging, those samples showed an increase in hardness of only 18 points from 46 to 64 durometer; elongation went down from 320 to 105%; tensile strength dropped only 26 points from 557 to 531 p.s.i.; and there were no significant changes in any of their dielectric properties.

And that is almost incredible performance at temperatures high enough to change any other kind of rubber to a brittle, noninsulating material in a few hours or days at the most. When you need rubbery properties or good dielectric properties in a resilient material that will withstand weathering or long exposure to temperatures above or below the limits of ordinary rubbers, specify Silastic.

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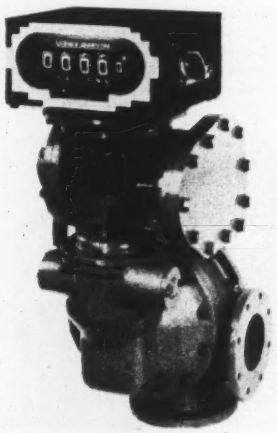
Industrial Meter

A new 2 BC Rotocycle stainless-steel industrial meter has been developed by Rockwell Mfg. Co., Pittsburgh, Pa., to handle corrosive liquids common to the cellulose, chemical, confectionery, food, oils and fats, rubber, pharmaceutical, and industrial processing fields.

Based on the patented Rotocycle Principle, this new rotary displacement meter features a maximum capacity of 100 gpm at a working pressure of 125 psi. All materials in contact with corrosive liquids are of stainless steel insuring satisfactory operation.



Remote registration, which provides for transferring the reading of the meter register by electrical impulses to a central control room remote from the point where actual measurement takes place; a quantity control register with a built-in electric switch that is actuated after a predetermined volume of liquid has passed through the meter; swivel adapters, angle adapters, and register extensions can be supplied with the meter.

Forging Presses

Officials of the United States Air Force and the Aluminum Co. of America announced the completion of negotiations on a contract that will bring two of the largest forging presses in the world to Cleveland, Ohio.

The presses of 35,000 and 50,000-ton capacity will be housed in a structure equivalent in height to a 10-story office building. They are expected to be put in operation in 1954. The 50,000-ton press will have an over-all height of 80 ft, 36 of this below ground level. The 35,000-ton press is 38 ft wide, 65 ft long, and 49 ft high. Steel reinforced concrete foundations extending 30 ft underground and resting on pilings reaching 75 to 80 ft downward will be needed to support the heavy machinery.

The presses will be operated by Alcoa in a Government-owned plant adjacent to the Cleveland Works of that company. The total cost of the plant will be about $40 million. The company is spending several million dollars of their own money on supporting facilities.

Two outstanding Pittsburgh organizations are constructing the presses—Mesta Machine Co. and the United Engineering Co.

The presses will be used primarily to make structural aluminum and magnesium forgings for high-speed aircraft.

Forgings—closed die forgings—with their unmatched economic and mechanical advantages offer quick and complete solutions for Problem Parts problems confronting any member of a production team.

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Basic principles of aircraft construction have led to undergo an almost revolutionary change with the advent of jet propulsion and supersonic aircraft.

Wing-loading stresses resulting from speed and maneuverability have reached levels where conventional construction—stamped ribs, sheet, rivets, and such type construction are giving way to plate, large forgings, and extruded sections of basic structural materials.

Single-Disk Clutch

As an addition to their Maxitorq multi-floating disk Clutch Series, the Carlyle Johnson Machine Co., Manchester, Conn., has announced the Johnson single-disk clutch.

It is specifically designed for light machinery service up to 6 hp—the No. 350, 3 hp, No. 450, 6 hp. If spacesaving is not of prime importance, the new Johnson will provide far greater capacity at low cost. They incorporate the same "floating disk" principle that has won wide acceptance for the Maxitorq by manufacturers of machinery and motorized products. The disk rides free in neutral, preventing drag, abrasion, and heating. A simple hex-key frees the knurled ring for easy manual clutch adjustment.

Typical applications are: medium farm machinery, packaging and bag making, hoists, loaders, textile, tobacco, sorters, spreaders, fans, saws, conveyors, mixers, dusters, pumps, and many other similar machines.

Silicone Resin

A new silicone resin for Class H electric insulation that maintains its bonding strength and hardness at temperatures 50–90 C above any known commercially available silicone resin has been developed by the General Electric Co. Chemical Divison.

Designated as SR-98, the new product permits greater design flexibility in motors, transformers, and generators where vibration is a factor. Because of its excellent bonding strength and lack of flow at elevated temperatures, coils and other rigidly mounted components are held more securely in position than with former silicone resins.

Having excellent solvent and abrasion resistance over a wide temperature range, SR-98 forms an exceptionally hard, tough, insulating film. It is suited for bonding and impregnating coils and insulating materials used in Class H electrical equipment. When used to treat glass cloth, asbestos paper or cloth, and mica products it produces a more rigid type of product.

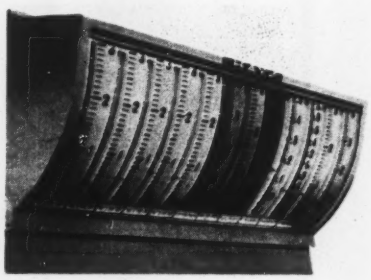
General Electric's new silicone resin is supplied at 50% solids content and is light amber in color. It can be thinned with xylene, toluene, or petroleum spirits. No catalyst is required.

SR-98 has also been used successfully as a vehicle for caulking and sealing compounds. Filled with an inert material such as mica dust or talc, 25–50% by weight, the resulting paste may be applied between layers of coil insulation. A heat-stable seal results after curing.

Vertiscale

Now available from Hays Corp., Michigan City, Ind., is the Vertiscale, a new draft gage, which incorporates features that provide many desirable benefits. Among these features are: 3-way atmospheric vent; easy "one man" zero check; large identification label space; magnetic access door; fluorescent lighting for easy reading; removable units; no parallax; dusttight case; and Lucite scales.

Like other Hays draft and low-pressure instruments, the Vertiscale basic operating mechanism consists of a diaphragm, enclosed in a cast metal housing, the force and movement of which is balanced against the force of calibrating springs. The resultant force and movement of the diaphragm is transmitted through linkage to the pointer to indicate the magnitude of the draft, pressure, or differential to which the diaphragm element is subjected.



From 1 to 12 units of the Vertiscale can be mounted side by side in a single case. Streamlined in design this new gage is available in four types of mounting to meet special requirements of individual installations: a semiflush mounting; a recessed mounting for above eye-level reading; an eye-level mounting and a projected or lug mounting.

The gages can be obtained with a spring-loaded metallic bellows for indicating functions such as level, flow, temperature, and pressure pneumatically transmitted by other instruments. Ranges from 0.2 in. of water to 120 in. of water, draft, and differential can be provided.

Compact Motor Drives

Twenty-four 47-ton hanger doors in the new $4½ million Boeing Airplane Co. jet bomber flight hanger in Wichita, Kan., are raised by compact motor drives that contain high load-carrying capacity standard Cone-Drive speed reducers made by Cone-Drive Gears Div., Michigan Tool Co., 7171 E. McNichols Road, Detroit 12, Mich.

The new hanger can house 12 of the 600-mph six-jet Boeing B-47 Stratojets now rolling off the Wichita Division's assembly lines at the rate of more than one per working day. When all the hangar doors are open, they expose the entire sides of each of the hangar's three bays measuring 265 ft × 195 ft.

Each of the 47-ton hangar doors is operated by a 15-hp motor that drives a shaft turning six cable drums through a standard Cone-Drive double-enveloping type worm-gear speed reducer. The doors measure 55 ft high × 66 ft wide.

The cantilever-type hangar, which is used for flight line operations in the production of the B-47 jet bombers, is the biggest project in the recent $32 million expansion program at the Wichita plant.

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Analog-To-Digital Converter

Most dynamic testing of structures and devices consists of perhaps hundreds of repetitions of the same tests with conditions changed only slightly between runs. Data gathered during such a test series is usually in the form of an "analog" plot, i.e., a chart on which a line's position varies in proportion to the force being measured. Picking individual points from such a plot is often the greatest bottleneck in reducing the test data to usable form, for until such points are selected and measured, the numerical or "digital" values cannot be determined. Without numerical information, engineers cannot proceed to the final step in data reduction, that of computation.

The SADIC, Consolidated Engineering Corporations' of Pasadena, Calif., new Analog-to-Digital Converter, completely eliminates the analog plot and directly converts the test measurements from standard pressure pickups, thermocouples, and strain gages to numerical values. These are immediately and automatically typed or printed out on tapes, or they can be punched into standard cards for automatic processing. Not only is the process of data reduction—the conversion of simple measurements to usable engineering information—vastly speeded up, but the possibility of human error is virtually eliminated.

Accuracy is a prime feature of the SADIC. Numerical measurements indicated by its lighted panels and printed on its readout equipment are accurate to within 1 part in 1000. This $^1/_{10}\%$ validity is coupled with a speed that allows measurements to be sampled as often as once every second. Thus, any device or structure— motors on test stands, wind-tunnel models, and hydraulic systems for example—which can reach a semistabilized condition, can be tested in actual operation.

Flexibility of the SADIC systems allows any number of measurements to be simultaneously converted to digital form. Although each SADIC is used for only one phenomenon, systems of any number of channels may be assembled and expanded at any time. In this way, investigations of either the simplest or the most complex structures can be greatly simplified. Standard, commercially available transducers and pickups are used as the original sensing elements for stress, strain, pressure, acceleration, temperature, and other phenomena.

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Conveyer Belt Press

The world's largest conveyer belt press is being installed in Goodyear Tire & Rubber Company's huge flat belt production lines in Akron, Ohio. The 41-ft-long press uses up two floor levels and plant buildings had to be revised for installation.

Designed and built by Farrel-Birmingham Co., with the aid of Goodyear belting engineers, the gigantic press, more than 80-in. wide is capable of vulcanizing conveyer belts up to 72-in. wide, one-third as wide as the standard two-lane highway.

Increased demands for conveyer belts with greater payload capacity by industry and the impending boom in passenger conveyer belt systems prompted Goodyear to install the press.

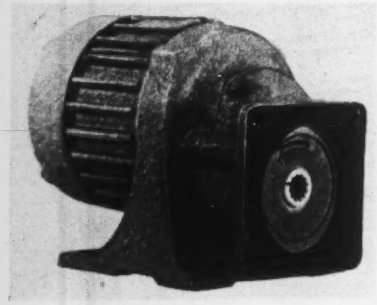
The belt press is arranged with equipment at each end to enable it to take up to a 20-ton belt. Equipment allows 1500 lb of working pressure on each of the 32 18-in-diam rams which in turn will give 275 psi pressure on press plates.

The press covers an area of about 2,500 sq ft including wind-up, let-offs, and piping. It will weigh approximately 600,000 lb, exclusive of wind-ups and let-offs. The press will be used exclusively to vulcanize conveyer belts.

The only other belt press built approximating the size of this one was designed by Farrel-Birmingham for use in Europe. That press measures 34 ft in length and 84 in. in width.

Explosionproof Aircraft Motor

Applications in hazardous locations requiring low-speed aircraft motors can now be met through a recent development of the Aircraft Division of U. S. Electrical Motors Inc., Los Angeles, Calif. Rated at 1½ hp. continuous duty, 400-cycle, 3-phase a-c motors with internal gearing and double-enclosed construction are now in production at U. S. Motors.



Features of this unit include hardened and shaved helical gears, integral fan, heat-dissipating fins, pyramidal base to withstand high "G" loads, internal spline take-off shaft, AN mounting pad, thermal overload protection, rapid acceleration, and high starting torque.

Rolling Mill

The nation's first large mill specifically designed for the rolling of tapered aircraft skin sheets is to be installed by the Aluminum Company of America at its Davenport, Iowa, plant. The unique installation will produce extra-wide tapered sheets and result in reduced assembly time for wing sections on tomorrow's airplanes.

Capable of a maximum delivery speed of 120 fpm, the 144-in., 4-high reversing mill will be driven by a 3000-hp, d-c motor, supplied by the General Electric Company.

Wide speed ranges from 80 rpm to as low as 5 rpm will be required of the big motor, since mill speed must be maintained in ratio to the speed of motor-driven screws which adjust roll separation to produce desired thickness in the plate.

Designed, installed, and operated by Alcoa under Air Force contract, the new mill will turn out skin plates up to 10 ft wide and more than 33 ft long. Present limits are slightly more than 5½ ft and 25 ft, respectively.

Thickness of the finished product will vary from 1.5 in. down to 0.064 in., while the maximum taper ratio will be 4.5 to 1 with a maximum tapered rate of 0.050 in. per ft of sheet.

Besides the main drive motor, G-E will furnish a 2500-kw synchronous motor-generator set, 2300-volt switchgear, complete controls, ventilating equipment, and a 5000-kva transformer.

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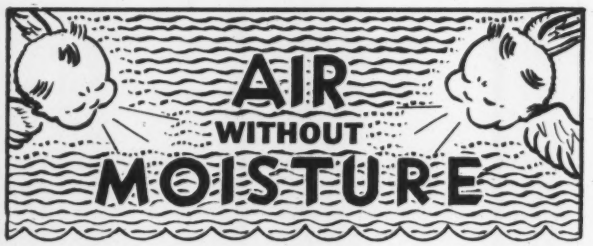

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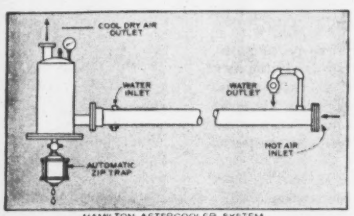
Come down to earth where the air is dry.



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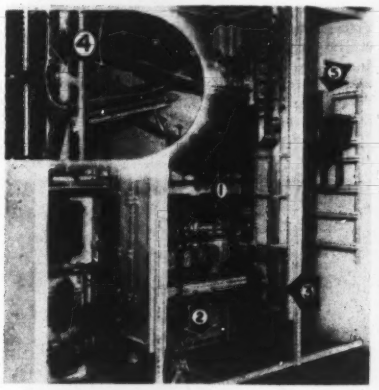
Automatic Control Panel

The accompanying photo shows the rear view of a typical automatic control panel incorporating the newest developments in panel design and construction.

Instrument and control engineers in power and process plants have been continually demanding more instruments at no increase of operating space or sacrifice of maintenance ease. In 1947, Bailey Meter Co. of Cleveland, Ohio, put its panel design engineers to work on the project. The results illustrated and described here represent an analysis of several hundred control panel installations. The following advancements are numerically keyed to the panel illustration.



1 Complete accessibility now provided through the utilization of vertical support areas. These are systematically spaced and divide the panel into bays of associated instruments and operating lines.

2 Control room floor openings and external tubing and wiring conduits may be completed well in advance of panel installation. Panel bay widths are easily determined once the major instruments have been selected and located.

3 Tubeways have been created to provide centralized distribution points. Panel tubing is concentrated on sturdy vertical supports designed to carry all necessary instrument control lines and meter pressure lines from remote points to panel mounted instruments.

4 Wireways enclose well-marked, compact, but easily accessible electrical terminal blocks. Installing, testing, and tracing procedures by user can now be done in a minimum of time and with least possible inconvenience or error. Additional terminals may be added without obstruction to existing facilities. Individual wire bundles are now carried out of wireways at points nearest to instrument and switch terminals.

5 Adjustable wall racks facilitate mounting of any make control boxes, alarms, relays, breakers, etc. This construction also permits installation of additional equipment without welding special mounting pads to panel walls. Old method of welding caused charring of panel walls both inside and out, thus necessitating refinishing and repainting either all or sections of panel walls.

In the panel shown, approximately 12 sq. ft. of additional equipment and tubing may be mounted without affecting the accessibility to instruments and controls. Construction technique provides same strength as conventional type panels, yet affords flexibility which was never before realized.

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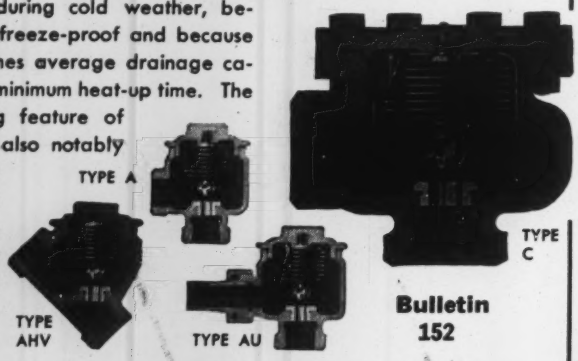

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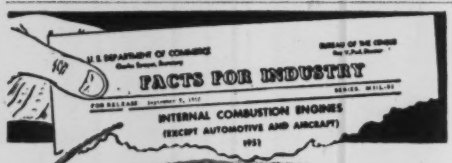

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6 to 9 hp.

Proof of Top Preference for

7 to 14½ hp.

15 to 36 hp.

WISCONSIN HEAVY-DUTY Air-Cooled ENGINES

Based on data contained in a "Facts for Industry" report released on Sept. 5, 1952 by the U. S. Bureau of the Census, an aggregate average of 50.61% of all carburetor type internal combustion engines produced during 1950-'51 within an 11 to 175 cu. in. displ. range (approx. 3 to 40 hp.) were WISCONSIN HEAVY-DUTY AIR-COOLED ENGINES (exclusive of aircraft, automotive, outboard marine and "captive" engines built by various manufacturers for use on their own equipment).

Here is positive proof of top preference for Wisconsin Engines both by original equipment manufacturers and users of power-operated equipment. Proof of constantly growing recognition of the special adaptability of these fine engines to fit both the machine and the job. Proof of heavy-duty dependability and trouble-free air-cooling under weather and climatic extremes.

Wisconsin general-purpose Air-Cooled Engines have been *pre-judged and pre-selected* by more power-wise purchasers than ALL other makes of engines combined, within a 3 to 40 hp. power range. Perhaps it's your turn to specify "Wisconsin". Descriptive literature and engineering data on request.

WISCONSIN MOTOR CORPORATION

World's Largest Builders of Heavy-Duty Air-Cooled Engines

MILWAUKEE 46, WISCONSIN

A 7388-⅓

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BUSINESS NOTES
LATEST CATALOGS

Wire Inserts

Stainless-steel wire thread inserts used in a plastic insulator block of an automatic arc welder solve three problems for the Air Reduction Co., Inc. of Murray Hill, N. J., according to Heli-Coil Corp., Danbury, Conn.

They provide threads in this laminated phenolic block that: (1) will not strip under excessive load, (2) are virtually impervious to wear, and (3) provide a unique brake-band type lock around a threaded adjustable bushing so repeated adjustments can be made without damage to the bushing.

This block—a key component in the welding-wire feed section of the company's Aircomatic welding unit—must (*a*) prevent welding current in the continuous wire from grounding out through the supporting frame, (*b*) support the adjustable threaded bushing through which the continuous welding rod passes as it travels from supply reel to gun delivery tube, and (*c*) provide a means for precise adjustment so that different sizes of welding wire can be accommodated.

Each wire-feed insulator block contains three Heli-Coil thread inserts. Two, in the set-screw holes strengthen the plastic threads against stripping and protect them from wear. The third, in the larger hole, provides the same protection and also acts as a brake band around the threads of the adjustable wire-feed bushing.

A change from one size of welding wire to another requires loosening of the set screws, insertion of a different size nylon sleeve in the wire-feed bushing, and readjustment of the bushing so the tip of the nylon supporting member is close to the feed rolls (to prevent wire buckling). When this is done, the adjustment is maintained by tightening the set screws.

Because thread inserts provide higher thread flank engagements, insert-protected holes will safely withstand higher loads. As a result, high torque loading will not strip the protected set-screw threads. Also, frequent adjustments will not cause any appreciable wear of the stainless steel thread liners.

The large Heli-Coil insert prevents the set screws from marring the thread on the adjusting bushing. Because the insert is flexible, it clamps the bushing when set screws are tightened and releases it when they are loosened.

For Consulting Engineers Turn to Page 142

Now!

STEAM AND MECHANICAL ATOMIZATION COMBINED . . .

NATIONAL AIROIL DUAL STAGE OIL BURNER

Now, at last, the inherent advantages of both systems of fuel oil atomization are *profitably* yours . . . within the one, new NATIONAL AIROIL Dual Stage Burner.

41 years of combustion equipment design and manufacture are in back of the Dual Stage Oil Burner . . . and, it has been thoroughly tested and proved in the field for firing: Petroleum Processing Heaters; Rotary Kilns; H. R. T., Scotch Marine and Water Tube Boilers; etc.

Available in three sizes, the NATIONAL AIROIL Dual Stage Burner fires all grades of fuel oil from No. 2 to No. 6, with a ready capacity of 80 to 300 g.p.h. Further, for a perfect flame pattern, we would recommend using with the Dual Stage Burner either the NATIONAL AIROIL Universal Register for forced draft or, the NATIONAL AIROIL Tandem Units for natural or induced draft furnaces.

Get detailed description, illustration, and specifications in NATIONAL AIROIL Bulletin 25.

National Airoil Burner Co.

1239 East Sedgley Ave., Philadelphia 34, Pa.

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in inch ounces . . . inch pounds . . . foot pounds All Sizes from 0-6000 ft. lbs.

Every manufacturer, design and production man should have this valuable data. Sent upon request.

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NEW EQUIPMENT
BUSINESS NOTES
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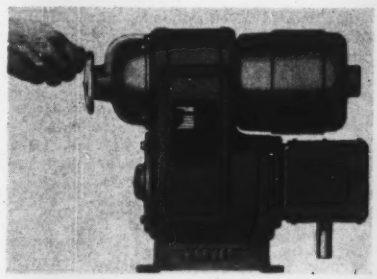
Variable Speed Right-Angle Drive

Reeves Pulley Co., Columbus, Ind. announces the addition of a fractional HP Vari-Speed Motodrive with right-angle reducer to its line.

The Reeves Motodrive with right-angle reducer combines in one spacesaving unit any standard NEMA frame, type "C," face-mounted motor; the time-tested Reeves speed-varying mechanism; and the new right-angle worm gear reducer. This new right-angle reducer is available on all fractional HP Motodrives in either horizontal or vertical models; with speed ratios from 2:1 through 10:1.



The compact design of this new drive assures a self-contained unit that is small and compact, yet extremely rugged. The output shaft drives up, down, or at right angles in the horizontal type of units and drives down or at right angles in the vertical model. The right-angled shaft arrangement is of great advantage in many applications—saving valuable floor space by making it possible to put the fractional HP Motodrive flat against the driven machine or by mounting the Motodrive directly above or below the driven equipment.

The right-angle reducer, an alloy-steel helical worm and bronze gear, is built to withstand heavy duty, continuous operation. All gearing and bearings are adequately lubricated and the case is properly sealed to insure against any oil leakage.

Handwheel control is standard on these drives but electric remote and mechanical automatic controls can easily be applied.

Bucket Elevator

The Omega Machine Co., Providence, R.I., has designed a small, compact bucket elevator for loading feeder storage hoppers in limited areas.

The new elevator, model BES-77, houses its malleable iron buckets in a 9 × 24-in. steel casing which is considerably smaller than the average size elevator currently on the market. These compact dimensions permits its use in chemical feeder rooms where minimum floor space is an important factor.

The boot, head, and center section is fabricated of 12-gage mild steel and can be constructed to an over all height of 25 ft, if necessary. Each section has flanged ends and dust-tight joints.

Driven from a $1^1/_2$-hp gearhead motor, the feed buckets travel on pintle chain from boot to head at a maximum delivery of 200 cu ft per hr. Dust collectors, bin-level switches, and other accessories are available with this equipment when required.

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Steam Gage Illuminator

A new illuminator for steam gages, the Jerguson mercury vapor illuminator, announced by Jerguson Gage & Valve Co., 80 Fellsway, Somerville, Mass., permits instant and accurate gage readings of the boiler water level over longer distances, through dust particles in the air or deposits on the gage glass, or in poorly lighted areas.

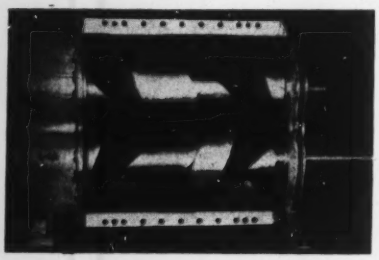
When a gage is equipped with a mercury vapor illuminator, the water column shows blue-green, topped with an intensely brilliant emerald green spot at the water level, to give an unmistakable water-level indication. The illuminator is designed to take full advantage of optical principles. It consists of a mercury vapor bulb enclosed in a steel housing, and a ballast box equipped for easy mounting at a convenient spot. The illuminator clips to the gage cover with two sets of brackets, making installation easy with no alterations to the gage.

The mercury vapor illuminator is furnished in weatherproof construction suitable for outdoor use. It is made in sizes to fit standard gage sizes, and is also available with a 100 watt incandescent bulb for use on low-pressure steam-service gages.

Spiraxial Compressor

A gas or air compressor called the "Spiraxial Compressor", entirely new in principle and design within its range, was introduced by Roots-Connersville Blower, Connersville, Pa.

A plastic-enclosed model of the new unit shows the functional operations of its "Spirotor" construction.



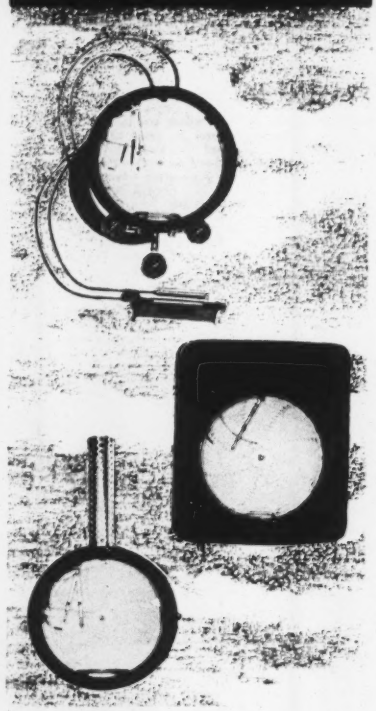
Instead of conventional rotors, the Spiraxial compressor employs two intermeshing screw-rotors which rotate in opposite directions. These screws are operated by gears synchronized to prevent contact, allowing close but definite clearances between them. The "Spirotors" are formed along a spiral surface accurately generated to maintain correct clearances.

The Spiraxial compressor is designed to increase the flexibility of the R-C dual-ability line by bridging the gap between the conventional rotary positive and Centrifugal compressors.

The manufacturer cites these advantages over present types of equipment: (1) Peak efficiencies at discharge pressure determined by requirements. (2) No internal lubrication used or needed. (3) Minimum of servicing, with wearing parts quickly accessible. (4) Low noise level and smooth operation. (5) Lightweight.

The new compressor, according to the company, is based on the long-proved rotary blower, originally conceived by the Roots Brothers in 1854, but entirely new in operating principle.

WIDEST RANGE OF
EQUIPMENT FOR
HUMIDITY
RECORDING



No matter what problems you face in obtaining suitable humidity measurements and records, the unique versatility of Foxboro Humidity Instrumentation offers an appropriate solution. Included are Recorders, Recorder-Controllers, Indicators, for relative humidity (hair and membrane), wet-and-dry bulb measurements, and for direct reading dewpoint or absolute humidity measurement (with the exclusive Dewcel element). Available in portable, close-coupled and long-distance types; with round or rectangular cases.

Write for full details in Bulletins 188-5 and 407. The Foxboro Company, 962 Norfolk St., Foxboro, Mass., U.S.A.

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HUMIDITY
INSTRUMENTS

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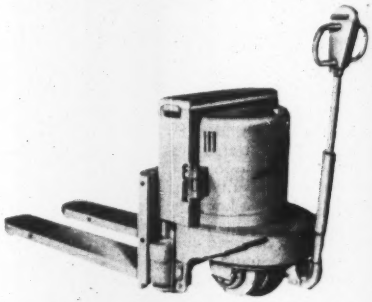
Pallet Trucks

The first 1953 models in the Powrworker lift-truck line have been announced by the Clark Equipment Co., Buchanan, Mich. The new models are pallet trucks, electric battery-powered, with a capacity rating up to 6000 lb. These pallet trucks can be supplied with pallet forks to handle any size pallet, either single or double faced.

Walk it or ride it, optional models of the 1953 Powrworker Pallet Truck are available. One is arranged for single tray (1 × 6) layout of battery, while the other accommodates a double tray (2 × 3) layout of battery.



Powrworker pallet trucks feature double hoisting cylinders for lifting the loaded pallet, motor-in-wheel drive, full time delay control with all contactors interlocked for smooth, progressive speed positions, positive safety-spring return handle which applies brake and cuts off power, and a bumper guard located higher to avoid operator injury. Cast-steel frame, forks, and elevating carriage provide an over-all unit of great strength and stability.

The Powrworker is the shortest pallet truck capable of carrying a double-tray battery. This combination assures maximum service with great utility in congested operating quarters.

"Non-Slip" Handwheel

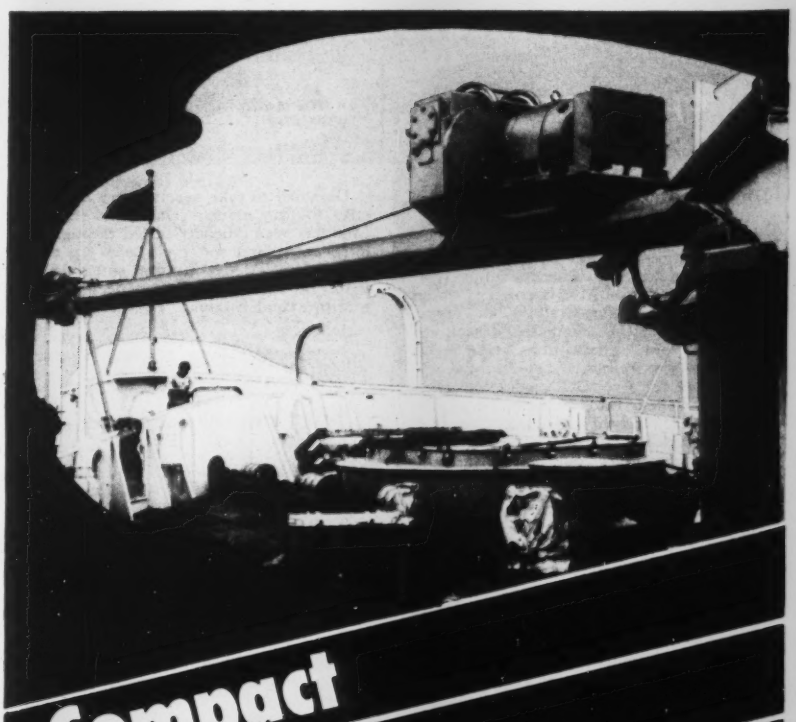
A new "Non-Slip" handwheel has been patented and is being introduced by the Lunkenheimer Co., Cincinnati, Ohio.

Designed to turn easily and safely, the Non-Slip handwheel represents a scientific departure from the conventional type of valve wheel it replaces.

Lunkenheimer, currently observing its 90th anniversary, will standardize on this new handwheel for its complete line of bronze and iron valves, which formerly were equipped with regular malleable iron wheels. Like its predecessor, the Non-Slip handwheel also is made of malleable iron, but there the resemblance ends.

The new handwheel features four finger-spaced lugs, all continuations of the strong spoke structure, projecting from the stem hub through an exceptionally rugged octagonal frame. This design permits the operator to get a firm comfortable grip on the handwheel and apply a high pressure, even though his hand may be wet or greasy. The shape of the handwheel is such that it eliminates the possibility of burned hands from contact with the valve stem.

By virtue of its sure, easy grip, the Non-Slip handwheel assures complete, tight closing, thus eliminating leakage, a common cause of valve erosion, wire drawing, and failure.



Compact power for winches & hoists . . . with Cone-Drive Gears

Designed and built by Lake Shore Engineering Company of Iron Mountain, Michigan, this boom-mounted cargo winch is operated by Cone-Drive gears. Advantages include: ability to take shock loads, long-life, dependability, and unusual compactness.

Although a 20:1 ratio Cone-Drive gearset of only 7-inch center distance is used, this compact gearing provides a 27.7 mechanical horsepower rating at 1150 worm r.p.m.

No wonder leading producers of hoists and winches are turning more and more to standard Cone-Drive double-enveloping gears.

CONE-DRIVE GEARS
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
Division Michigan Tool Company
7171 E. McNichols Road • Detroit 12, Michigan

Ignition Shielding

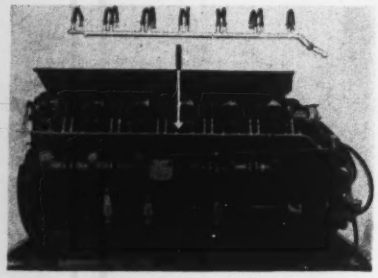
With a roar comparable to a small squadron of jet planes, the Army's newest and most modern medium (50-ton class) tank burst upon the mobilization scene this summer.

The deadly Patton M48 is powered by an 810-hp, 12-cyl Continental #1790 V-type, air-cooled engine, and is equipped with improvements and innovations from gun muzzle to rear couplings.

From the research and production engineers of Titeflex, Inc., Newark, N. J., the Patton M48 received its detachable lead ignition shielding harness. To eliminate interference from electronic waves, the ignition system and all lead wires in the continental #1790 engine are completely "walled off" with Titeflex flexible metal hose conduits.

In combat the M48 tank is literally a "mobile fort" with high-frequency, special band radio intercommunication between itself and other tanks in formation, and with direct radio contact to the field command post. The specially designed Titeflex ignition effectively blocks the development of electrical disturbances from engine circuits which might interfere with high-frequency radio broadcast and reception. In addition, the convoluted, flexible tubing conduit, with its tough wire braid covering and protective silicone rubber jacket, provides a durable protection for insulated lead wires and cables against abrasion, vibration and similar mechanical damage.

Designed to take nearly every obstacle of cross-country maneuvering in its stride, the M48 has been officially tested through mud, dust, snow, and water obstacles up to four feet deep. Titeflex ignition shielding eliminates the shorting hazards of deep water and moisture condensation. Even after hundreds



of test hours of constant vibration and frequent, complete submersion, ignition shielding on the M48 showed no signs of leaking. To protect all electrical lead wires from the deteriorating action of oils, greases, gasoline, and ethylene glycol, metal hose shielding is used exclusively on the new Patton tank. Titeflex conduits form a permanent and dependable protection against outside contamination and emergency ignition failures.

One of the major headaches to closed-in combat vehicle ignition systems has been heat build-up, which tends to destroy the insulation on lead wires. In the M48, however, the convoluted walls and wire braid reinforcing cover of the Titeflex shielding provide maximum heat exchanger surface and function to dissipate engine heat, even in the area next to the manifold, before it can reach the ignition wire insulation.

Multispeed Explosionproof Aircraft Motor

To meet specific needs of the aircraft industry, U. S. Electrical Motors Inc., Los Angeles, Calif., have just added a multispeed explosionproof motor with brake to their line of aircraft motors. Designed to operate in hazardous locations on 400-cycle, 3-phase alternating current, this unit develops $^1/_3$ hp at 11,000 rpm and $1^1/_4$ hp at 5200 rpm. With a d-c actuated brake, multispeed windings and explosionproof construction, this new unit is ideally suited for such applications as driving bomb hoists.

The motor is double-enclosed with fan blast being directed over the heat-dissipating fins for maximum cooling. Features of this air-craft motor include prepacked ball bearings, d-c actuated brake, explosionproof, moisture-resistant AN connector, thermal overload protection, two-speed windings, double-enclosed construction, AN mounting pad, high torque, and rapid acceleration.

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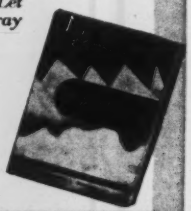

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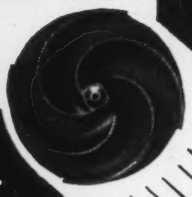

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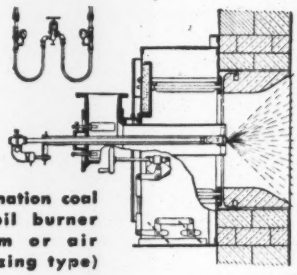
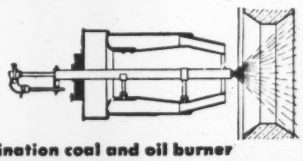
- **They permit operation with oil or coal—whichever is available and lowest in cost per BTU.**
- **All capacities of steam, air or mechanical-atomizing types are interchangeable**

The foregoing are only a few of the reasons why Enco oil-burners have been bought by a long list of leading industrial firms. Details of how Enco oil-burners can be adapted to your present pulverized coal burners will be gladly supplied—without obligation. Write The Engineer Company, 75 West St., New York, N. Y.



Combination coal and oil burner (Steam or air atomizing type)



Combination coal and oil burner (Mechanical atomizing type)

Enco Burners

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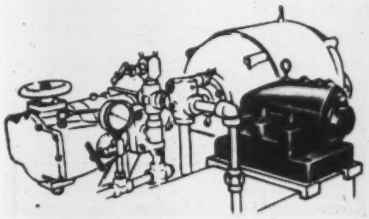
Hydraulic Control Valve

A new addition to the extensive line of hydraulic relief, sequence, and unloading valves, designed for high-pressure, high-volume circuits, has been announced by the Denison Engineering Co., Columbus, Ohio. This new 2-in. HydrOILic relief valve is built to provide dependable pressure control up to 5000 psi, with volume capacities up to 125 gpm. It features exceptionally low differential between opening and closing pressures, resulting in faster action, closer pressure control, and a reduction of over-pressure and pressure-drop conditions.

Greater efficiency, resulting in better circuit operation is made possible by the extremely close fit of all sealing surfaces within the valve body, reducing leakage to almost zero. Pressure setting is adjusted by a knurled screw on the valve cap. Provision is also made for remote control of this regulation.



This new valve is furnished with either threaded body or for subplate mounting. In the average hydraulic circuit, the flow limits the volume capacity of the relief valve. However, with this new valve, greater than normal volume can be successfully controlled, if the valve is T'd off the pressure line; then oil flows through the valve only when relieving the circuit in excess of the pressure setting.

When using the subplate type mounting, the relief valve is necessarily T'd off the pressure line, because of its design. The piping is connected to the subplate and the valve is mounted on the plate. This type of installation provides a means of removing the valve at any time without having to break the pipe connections. In instances of higher pressure installations where heavy pipe is required, the distortion caused by the threading of pipe, which often causes faulty operation, is eliminated.

Power Machine

A new power machine for notching sheet material has been announced by O'Neil-Irwin Mfg. Co., 569 Eighth Ave., Lake City, Minn.

Designated Di-Acro power notcher, the use of this new machine in some metal-working operations saves a large part of the cost of expensive dies and heavy presses. A notch as large as 6 × 6 in. can be made in 16-gage sheet steel, and notches both larger and smaller than 90 deg, as well as some straight shearing jobs, can be performed by making a few simple adjustments.

Additional advantages are: (1) High rate of production—up to 180 strokes per min, (2) minimum operator fatigue—especially valuable on long production runs, (3) simple operation—foot-actuated clutch leaves both the operators hands free for work handling and single-stroke action of clutch pre-

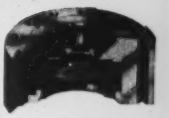
STOP COSTLY WATER HAMMER NOW!

WILLIAMS-HAGER FLANGED

Silent

CHECK VALVES

Williams-Hager Flanged Silent Check Valves are the economical and dependable answer to troublesome and costly "water hammer" in all pump lines. These valves operate effectively in horizontal, vertical, upside down or angular positions—under any service or pressure condition.



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This new Standard gives the tolerances to which industry is building 12 in. to 18 in., 20 in. to 32 in., and 40 in. to 72 in. lathes; also the test requirements for checking accuracy and alignment.

B5.16-1952 $1.00

ACME SCREW THREADS

A revision of the 1945 document, this 1952 Standard specifies three classes of general purpose and five classes of centralizing threads, and gives basic dimensions, tolerances and allowances, and limiting dimensions for the standard series of diameters and pitches. Formulas for special diameter-pitch combinations are included, also appendixes dealing with gages for both threads and an alternative series of centralizing threads with minor diameter centralizing control.

B1.5-1952 $2.25

STUB ACME SCREW THREADS

This Standard, a revision of the 1945 publication, is limited to one class of thread, corresponding to the 2G general purpose Acme thread. Specified are the angle, height and thickness of the thread; allowance at major and minor diameters; the basic dimensions; special diameters; and the selected series of diameters and pitches. Appendixes give basic data for two modified forms of Stub Acme threads having basic thread heights of 0.375 and 0.25 pitch, respectively.

B1.8-1952 $1.25

New and Revised American Standards Published by

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SQUARE AND HEXAGON BOLTS AND NUTS

This new and greatly expanded Standard contains complete dimensional specifications as well as recommendations on standard materials. To make it a product standard, head dimensions of all series of hexagon bolts (with the exception of heavy bolts) and cap screws have been simplified by selecting as basic former across-flats dimensions of automotive hexagon head bolts or cap screws for sizes up to and including 9/16 inch size, and former across-flats dimensions of the regular hexagon bolts for bolts 5/8 inch size and larger, and by predicting the head height on a ratio of 5/8 size diameter. The light and regular series have been consolidated by selections of the dimensional proportions of the light series for sizes up to and including 5/8 inch and dimensional proportions of the regular series for sizes about 5/8 inch with the exception of the 7/16 inch size which is a modification of the light and regular series.

B18.2-1952 $2.00

ROUND HEAD BOLTS

In this Revision the depth of square of ordinary carriage bolts has been changed to use the limits previously applying to short lengths. Besides dimensions of carriage, button head, step, and countersunk bolts, dimensions of elevator bolts and T-head bolts, and an extremely short neck carriage bolt have been added. The Standard also specifies threads, length tolerances, and materials.

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vents accidental work damage, (4) dependable service—flywheel is driven by either a single or three-phase half-horsepower electric motor, (5) safety—danger from exposed moving parts is eliminated and greater work visibility is provided the operator by housing all moving parts in a steel cabinet, (6) compact—occupies a floor space 17 × 28 in., (7) portable—need not be bolted down; net weight is 465 lb, and (8) big 12 × 18-in. worktable—provides large material support area, makes for easier work handling and positioning. Gages for adjusting depth and angle of notch are mounted on the worktable for quick setup and changeover.

The Di-Acro power notcher is similar in construction to the Di-Acro hand-operated notcher which has been on the market for a number of years. Any manually operated model can be converted to power the company advises.

Snow Plow Attachment

The arrival of winter and the certainty of snow should remind fork-truck users that a snow-plow attachment is now available, according to the Clark Equipment Co., Battle Creek, Mich. The snow plow is designed for use on all Clark pneumatic-tired fork trucks excepting the 1000-lb trucloader.

The plow is a nonhydraulic attachment which is adjusted manually to several blade angles, and which is mechanically adaptable to uneven ground surfaces. The ballast box, mounted directly over truck forks, may be loaded with any kind of material to provide drive-wheel traction.

The blade assembly, 3/16 in. thick and 23 1/2 in. high, is attached to the plow mounting assembly by a single vertical pin around which the blade may be rotated for angle adjustment. Pushing blocks, located at the base of the plow assembly, enable the plow blade to exert maximum force at the base of the snow load, where the resistance is greatest. A compression coil spring acts as shock absorber.

The snow plow is readily detached as a unit and requires no tools for mounting or dismounting. Two metal legs at the base of the plow assembly permit it to be stored in an upright position. The plow is primarily designed for snow removal, but it may also be used for grading, back-filling.

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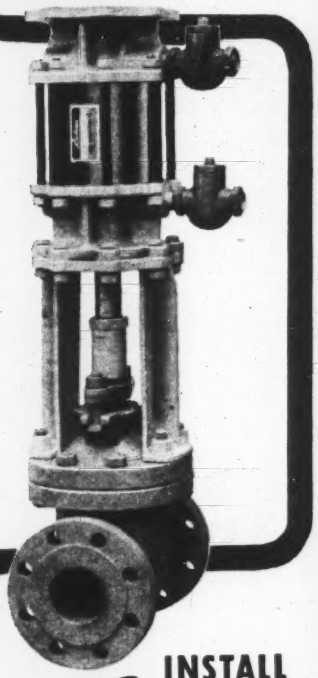

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Screw Calculator

To help engineers, specifiers, and others to select quickly the correct sizes of socket screws, Standard Pressed Steel Co., Jenkintown, Pa., has brought out a new, easy-vision screw calculator.

With it, all dimensions can be quickly obtained for a standard screw of given diameter. Threads per inch and the proper tap drill size in the National Coarse and the National Fine Series, and the body drill and counterbore sizes are given for each diameter.

Made of a wear-resistant plastic-envelope guide and a sliding member, the calculator, handy for shirt or coat pocket, is $6\frac{1}{2}$ in. long and 3 in. wide.

The calculator gives all vital dimensions on threaded items in the SPS line of Unbrako products. That includes socket head cap screws, hollow set screws, flat head socket cap screws, socket head shoulder screws, and the new SPS button head cap screws.

Screw diameters on the calculator are Nos. 4, 5, 6, 8, 10 and $\frac{1}{4}$, $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$, $\frac{1}{2}$, $\frac{5}{8}$, $\frac{3}{4}$, $\frac{7}{8}$ and 1 in. For any of these, proper adjustment of the sliding member will give the other dimensions of a screw through little transparent windows in the plastic envelope.

The other dimensions include the size of the socket in the head, the diameter of the head, height of the head, length of the screw below the head.

The dimensions of SPS Dryseal thread pressure plugs can also be found with the calculator. Because pressure plugs are designated in pipe sizes which cannot be measured directly, these measurable dimensions are a great aid in identifying such plugs.

A feature of the calculator is a listing of all drill sizes from No. 80 to 1 in. and their decimal equivalents.

The calculator can be obtained free by addressing Standard Pressed Steel Co., Box No. 558, Jenkintown, Pa.

Steel Mill Width Gage

A new noncontacting device which continuously and automatically measures the width of hot strip steel to an accuracy of $\pm \frac{1}{8}$ in. has been announced by the General Electric Company's Special Products Section, Schenectady, N. Y.

Called the steel mill width gage, it is the first equipment of its kind ever developed, according to G-E engineers, and is expected to become one of the basic tools of the industry.

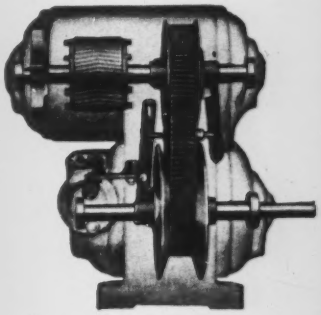
The width gage consists of a detector head, an operator's cabinet, and an electronic cabinet. Two phototube scanners are located in the gasket-sealed detector head mounted 15 ft above the hot strip steel. They pick up the light radiated from the strip and convert it into electrical signals. The resulting signals are two pulsating square waves. The square waves are each amplified, added together, and balanced against a standard voltage so that the difference produces a signal proportional to the width deviation.

The operator's cabinet contains a three-digit mechanical counter which indicates the width for which the gage is set, a deviation indicator, and the necessary controls and switches for setting basic width and making occasional calibration checks. In use, the operator sets the width indicator on the control panel to the width being run, and the detectors are automatically positioned

Magnetic Separator Efficiency Improved With Speed-Trol

Stearns Magnetic, Inc., of Milwaukee use Speed-Trols to drive their cross belt type magnetic separators for the beneficiation of such materials as wolframite, arsenic, pyrite, and monazite. Separation is based on varying degrees of magnetic response and Speed-Trols provide the accurate control of speed and wide speed range necessary to compensate for these variables and to achieve maximum separation of magnetic materials.

STERLING SPEED-TROL



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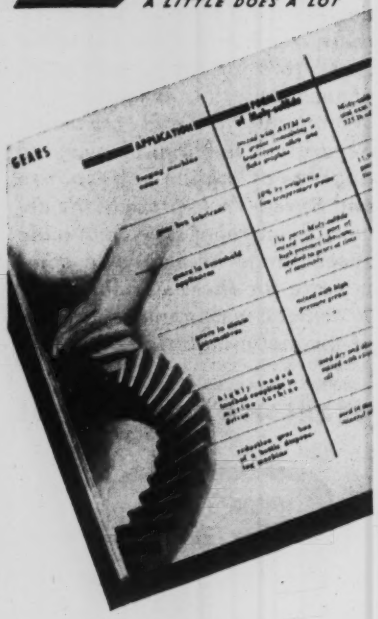

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over the strip edges by a motor-driven lead screw. The electronic cabinet contains a deviation indicator plus the majority of the electronic components of the gage. Optional equipment includes extra deviation indicators plus a deviation recorder for remote mounting.

Strip width of 10 to 96 in. can be measured at temperatures of 1350 to 2050 F and indicated in less than one second after the strip passes under the detector head. Strip position can change as much as three inches either vertically or horizontally without affecting the gage accuracy.

The height of the detector head over the strip keeps it away from scale, severe heat, corrosive fumes, and strip cobbles. No changes to the mill or mill table are required.

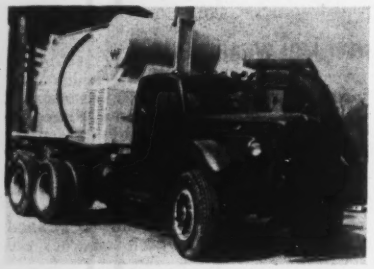
Power requirements are 550 volt-amp, 220/440/550 volts, three-phase 60-cycle.

Truck Mixers

A new line of inclined axis Hi-Up truck mixers featuring "engineered weight" to allow for greater legal payloads has been announced by Worthington Corp., Harrison, N. J.

Light weight has been maintained on the new mixers without sacrificing the heavy-duty characteristics ready-mix operators require. These mixers are also free of all unnecessary, trouble-making gadgets, the manufacturer states.

The Worthington truck mixers are built in three sizes, rated according to Truck Mixer Manufacturers' Bureau specifications. The 3-yd, 4½-yd, and 5½-yd machines are each available in two model arrangements. The Model L C is equipped with a simplified full-floating charging hopper with built in seal. The Model L O is equipped with a fast charging open-end-type stationary hopper. The machines can be rated and used as agitators.



Typical of the refinements of design incorporated in the new truck mixers are those of the Worthington drum. By manufacturing a drum of unusually large diameter, the center of gravity of the machine is kept well forward for maximum payload. Thorough mixing of concrete is also aided. The drums are fabricated of abrasive resistant steel with heavier gage at the mixing end. Overlapping drum joints are automatically welded on the outside, space welding on the inside for greatest possible strength at the seams. The abrasive resistant drum blades are die-formed at the discharge end of the drum so there is no resistance to the material being discharged. Correct blade angle, and the lack of any pockets or projections, make the entire blade assembly self-scouring.

The Worthington transmission is the simplest heavy-duty truck mixer transmission ever devised, the manufacturer claims. The

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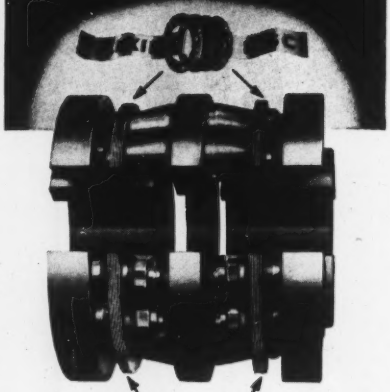
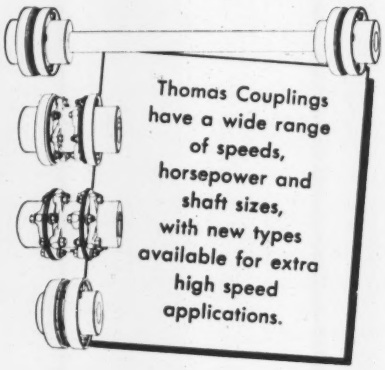


Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



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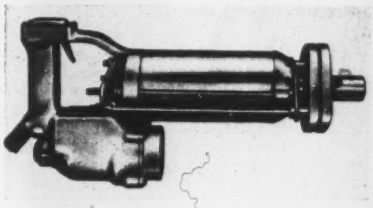
single pair of oversized spiral bevel gears are on the input end of the transmission where they run at engine speed. All other gears are spur toothed, heat-treated forgings. Clutches for controlling forward and reverse rotation of the drum are multiple disk clutches running in a bath of oil. The transmission has a positive centering device so the neutral position between forward and reverse clutches is automatically located.

Other advantages of the new machine are a simplified two-compartment round water tank, an improved, heavy-duty trunnion bearing designed by Worthington, die-formed distributing chutes and extensions, and greater use of automatic welding throughout. The mixers also contain numerous refinements designed to reduce operator fatigue and decrease operating hazards.

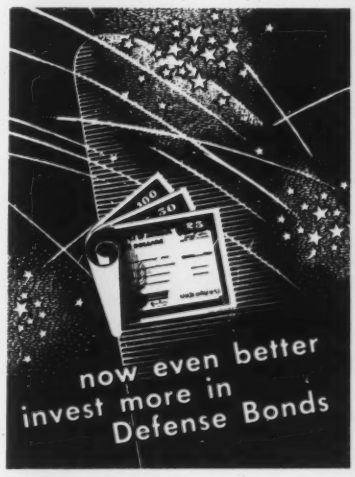
Electric Hammer Drill

The Syntron Co., 498 Lexington Ave., Homer City, Pa., has just brought out a new 2-in-capacity, heavy-duty electric hammer drill—the Model 26-RO.



Designed to speed up quantity hole drilling in concrete and masonry, this new Hammer Drill combines the power of their largest electromagnet hammer with automatic rotation of a spiral fluted, carbide-tipped drill bit. This automatic rotation is accomplished by a simple rubber ratchet mechanism which utilizes the recoil of each blow of the hammer piston to slightly turn the bit. Thus, the 3600 blows per minute of the hammer piston rotate the bit with considerable torque at the right speed.

This automatic drill bit rotation also eliminates the manual quarter turning of a drill bit—reducing operator fatigue. The spiral-fluted, carbide-tipped drills are available from Syntron in a variety of hole diameters.



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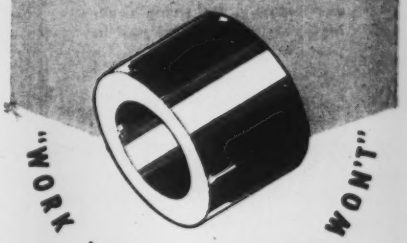

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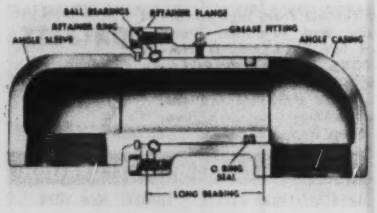
Swing Joints

Introduction of line of ball-bearing-equipped swing joints for use on loading and unloading lines handling oil, gasoline, chemicals, and other liquids is announced by Barco Mfg. Co., Chicago, Ill.

The design is distinguished by a long lubricated bearing which provides adequate support for piping and an exclusive method of positioning the ball bearings which prevents them from falling out when the joint is taken apart. Sealing is by means of an "O" ring confined in a recess in the sleeve of the joint. Special "O" rings are provided for handling gasoline, fuel oil, and other liquids without softening, swelling, or deterioration at any temperature from −30F to +250F. These joints are also suitable for pressures as high as 1500 psi hydraulic, depending on size and service. All parts are readily accessible for inspection.



Offered in steel for refinery, railroad, and other heavy-duty service, the new joints are being produced in 11 different styles, including counterbalance and double swing styles, and in four sizes, 2, 2½, 3 and 4 in. With this wide range of styles and sizes, Barco offers a large choice of layouts for loading rack arrangements.

Lint-Tight Enclosure

A newly designed, NEMA 1-A enclosure is now being used to make General Electric a-c combination motor starters lint-tight, according to an announcement by the company's Control Dept.

The enclosure features an oil-resistant (Buna S) rubber gasket which is preformed to fit over the edge of the control case. When the cover is closed, the gasket acts as a seat on which the cover rests. A close seal is thus formed, preventing the entrance of lint and minimizing fire hazard.

The "U" shaped gasket forms a compression seal that can be inspected easily without opening the control case, according to G-E engineers.

To further insure the seal against lint, a gasket for the reset button is provided and all corners and small drain holes which may remain in the case after fabrication are sealed with a metal filler.

The new G-E enclosure conforms to all requirements of the 1951 revision of the National Electrical Code.

Heating Forging Metals

The year passed witnessed an interesting example of using high-frequencies to heat metal for forgings, which is a comparatively new use of radio-frequency energy for heating, according to Westinghouse Electric Corp. In this particular application it is desired to bring an irregularly shaped billet up to 2100 F for forging into gas-turbine blades. These billets are about a foot long, weigh about a pound, and are roughly cylindrical but with two ball-like bumps near the center of the bar.

The high-frequency power for this task is supplied by four 150-kw, 9600-cycle motor-generator sets, which feed a total of 10 work-handling machines. A walking-beam and escapement arrangement feed the billets through the work coil at the rate of one every 15 sec. Special precautions are taken to prevent the billet from contacting the work coil enroute which would cause a short-circuit that would overload the unit or damage the part being heated. It was also necessary to design a unit that heats the billets without heating the carriage mechanism. A novel shape of carrier was developed in which two sets of currents are induced—but in opposite phase, and hence nullify each other. The carriers are also made of very thin metal to reduce the amount of heat induced in them at these comparatively low frequencies.

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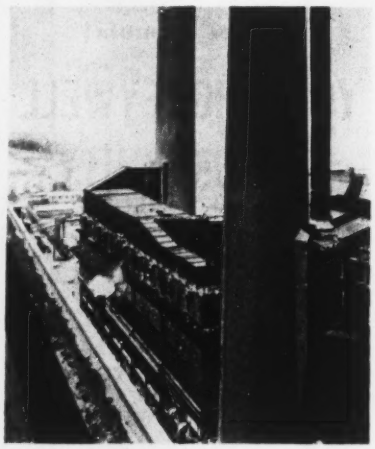
Cottrell Precipitator

Installation of a new type electrostatic precipitator using a wet-bottom flow method instead of a dry hopper and conveyer system for handling collected dust is near completion at the Union Bag & Paper Corp. plant in Savannah, Ga. Other precipitators used by Union are dry hopper types and addition of a wet-bottom precipitator is their first of the new type. A wet-bottom precipitator eliminates dry hopper auxiliary equipment costs and speeds return of collected material to pulp-making process. It was recently designed (patents pending) by Research Corp., Bound Brook, N. J., manufacturer of Cottrell precipitators.



The new precipitator at the Savannah mill will remove sodium sulphate from a spray-type black liquor recovery furnace handling 1,050,000 lb of black liquor solids daily. Precipitator will clean 160,000 cfm of gas at 275 to 300 F with 90% rated efficiency.

Five, as shown in the photo, were placed in operation to handle gases from nine recovery furnaces. These furnaces treat a total of 3,240,000 lb of black liquor solids per day at full load, representing a pulp production of 1200 tons per day.

Precipitron Oil-Mist Control Unit

A completely redesigned Precipitron oil-mist control unit that will recover the coolant oil from the mist and smoke generated by high-speed cutting, grinding, milling, and similar machining operations is available from Westinghouse. This redesigned oil-mist control unit is available in two models: Type PO-6 and PO-12. PO-6 has an air-handling capacity of 600 cfm; PO-12 of 1200 cfm.

Salvage or recovery of coolant oil is only one of the benefits made possible by this oil-mist control unit. Others are: (1) A reduction in such industrial hazards as slippery floors, fire hazards, reduced illumination, and contaminated atmosphere; (2) a savings in heating costs up to $300 a year per unit by not exhausting usable heated or conditioned air; (3) an improvement in employe attitude that comes from working in clean surroundings; and (4) a reduction in building maintenance costs such as structural members, windows, lighting fixtures, heating ducts, steam and water pipes; machine

tools and floors will not be coated over with a greasy film in an oil and smoke free atmosphere.

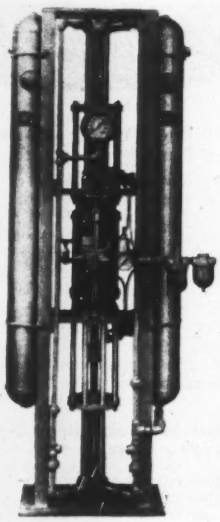
The Precipitron oil-mist control unit is completely self contained: the heavy gage sheet steel cabinet houses the all-aluminum oil-particle charging and collecting elements with their high-voltage power pack; the motor-driven fan; duct connection; and oil sump. The unit is shipped factory assembled and tested all ready to be floor-mounted or ceiling-suspended near the machine tool.

The fan motors are three-phase, fractional horsepower, ball bearing, prelubricated, totally enclosed, for 220 or 440-volt service. The power pack operates from a single-phase, 115-volt line and consumes less than 60 watts when operating. The PO-6 is 55 in. high, 22 in. wide, 24 in. deep, and weighs 265 lb unpacked. The PO-12 is 63 in. high, 31 in. wide, 27 in. deep and weighs 390 lb unpacked.

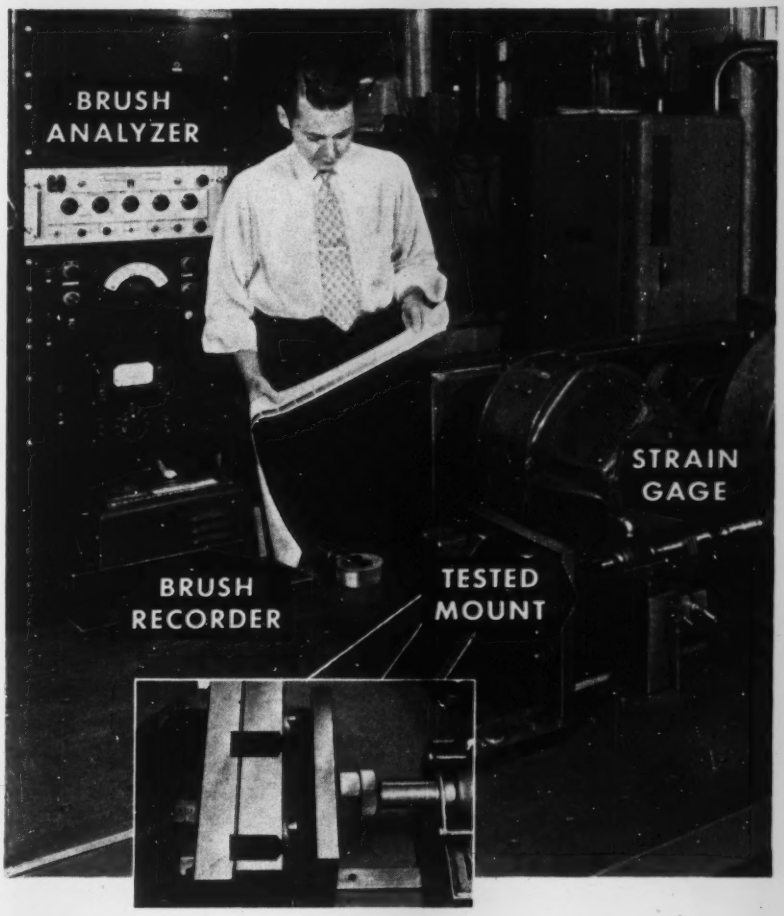
For further information, write Westinghouse Sturtevant Div., Dept. T-509, 200 Readville St., Hyde Park, Boston 36, Mass.

Air-Hydraulic Pumps

Ledeen Mfg. Co., Los Angeles, Calif., announces a new series of heavy-duty, air-hydraulic pumps and power units designed to develop high fluid pressure from low air pressure. Ledeen air-hydraulic units develop fluid pressure directly from plant air supply and are suitable for operation of high-pressure cylinders, clamps, valves, actuators, and hydraulic presses; for safety installation and high pressure testing; for special hydraulic circuits requiring variable and adjustable pressure and volume; and for long pressure-holding cycles with quick approach without overheating or churning the hydraulic fluid.



Built as a complete package power unit, ready for installation, these pumps and power units are available in horizontal construction for minimum head room, and vertical construction for minimum floor space. Both pressure and volume are readily adjustable. Normal air pressure is suitable, and very little air is required.



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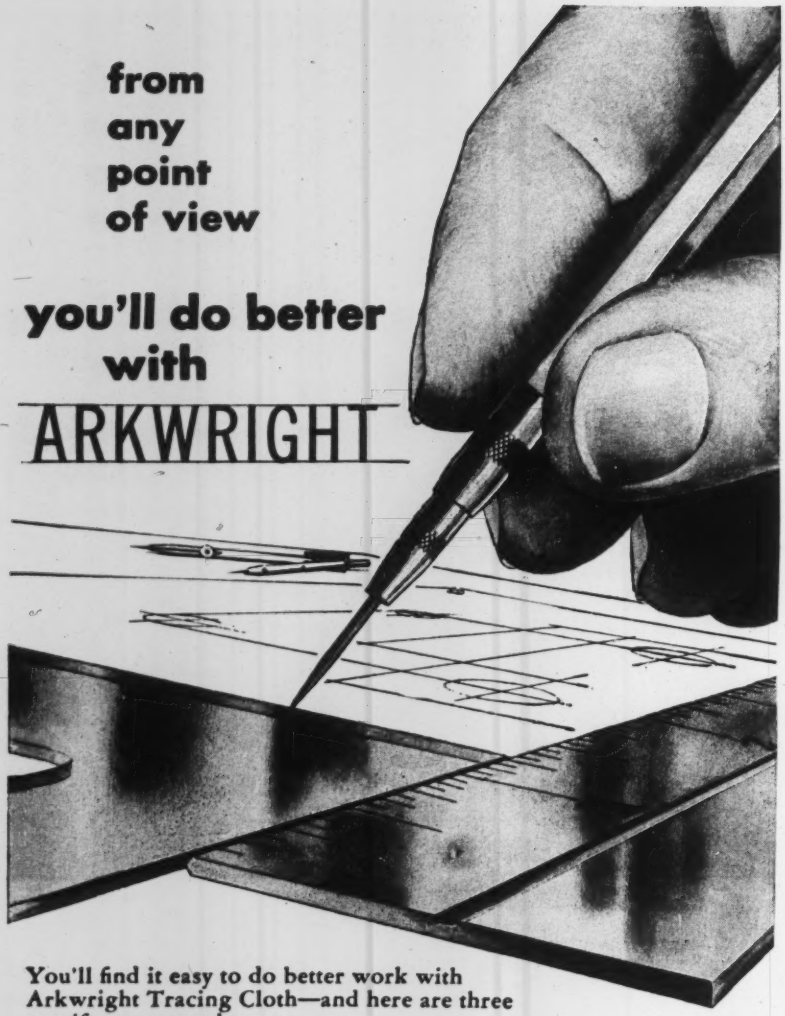

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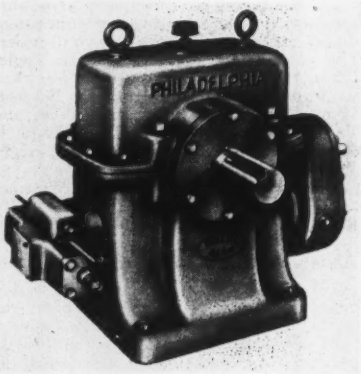
NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Speed Reducer

Designed for use as a conveyer drive, this type hat Philadelphia Worm gear speed reducer incorporates an automatic and instantaneous shut-off device for overload protection. This feature, known as a double torque control, eliminates the need for a sheer-pin coupling and has decided advantages over the latter means of protection.

When a predetermined load limit is reached, motor current is immediately cut off by direct mechanical action of the overload.



To restart operation after overload cut-off, only removal of excessive load is necessary. No resetting or replacement of parts are necessary—a considerable timesaving feature.

A wide range of horsepowers and ratios from 3 $^{5}/_{8}$ to 1 up to 6300 to 1 are available.

Business Notes

Denison Engineering Opens Chicago Branch

The Denison Engineering Co. of Columbus, Ohio, has opened a branch office at 4306 West 63rd St., Chicago 29, Ill., to not only serve Chicago and environs but also to headquarter the company's Central Regional Supervisory Office. To fully conform to Denison's long-established policy of rendering customers and prospective users of hydraulic equipment prompt and qualified engineering counsel, the branch is to be staffed by trained engineers and personnel of broad experience from the Columbus plant.

Consolidated Subsidiary Opens Larger N. Y. Office

Consolidated Engineering Corp. has opened new and larger offices for its subsidiary company, CEC Instruments, Inc., at 285 Madison Ave., New York, N. Y. The offices will handle sales and services for Consolidated Engineering's line of analytical instruments for science and industry, including the company's newly announced electronic computer and automatic data handling equipment. Similar offices have been opened recently in Washington, D.C.; Chicago, and Dallas.

Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Dravo to Emphasize Research

Research and development will play an increasingly important role in Dravo Corporation's diversified activities during 1953. Through the formation of a new department, all research functions of the corporation and its associated interests are now consolidated at Neville Island where laboratory facilities are under construction.

The facilities will include laboratories for paint testing, chemistry, metallography, and physical testing. A wide range of development work already has started, including studies of propulsion efficiency and maneuverability of river towboats, paints and protective coatings for ferrous metals used in steel structures like ore bridges, alloy linings for galvanizing kettles, and investigation of corrosion attacks on underwater sections of river vessels.

Another project of the department includes a process for treating industrial wastes by oxidation to prevent stream pollution and, in some cases, to recover steam for power production and process heating.

Scaife Celebrates 150th Anniversary

Scaife Co., oldest manufacturing firm in the United States west of the Allegheny mountains, celebrated its 150th anniversary last year. A brief simple program opened the new Scaife office building in Oakmont, Pa, and an "open house" for employees and their families marked the occasion.

The company has been engaged throughout its history in fabricating metals. It has been identified constantly with the growth of the nation, and the nation's greatest industrial city. But Scaife Co. was always quick to adapt itself to new public demands for products. It pioneered the familiar household range boiler many decades ago. In recent years Scaife has developed remarkable leadership in the development and production of pressure vessels and drawn shapes—among them cylinders for liquefied petroleum, refrigerant and acetylene gases, tanks for compressed air, water storage, and other tanks for the plumbing trade.

Oil-Free Compressors

Oil-Free compressors are discussed in Bulletin A-92, released by Joy Mfg. Co., Oliver Building, Pittsburgh 22, Pa. Specifications shown include Joy's complete line of nonlubricated compressors from 172 to 8800 cfm, 25 to 600 hp. The compressors described are designed for applications where lubricating oil must not contaminate compressed air—such as in instrument control, food processing, breweries, and distilleries, and in the manufacture of textiles, biologicals, and pharmaceuticals. These compressors of the vertical, v-vertical, and semi-radial type, are heavy-duty, water-cooled, double-acting machines designed for continuous 24-hr service. Lubrication within the cylinder is made unnecessary by the use of carbon-graphite piston rings. These rings, combined with completely functional metals and alloys are said to provide a dependable highly efficient air plant for this special service.

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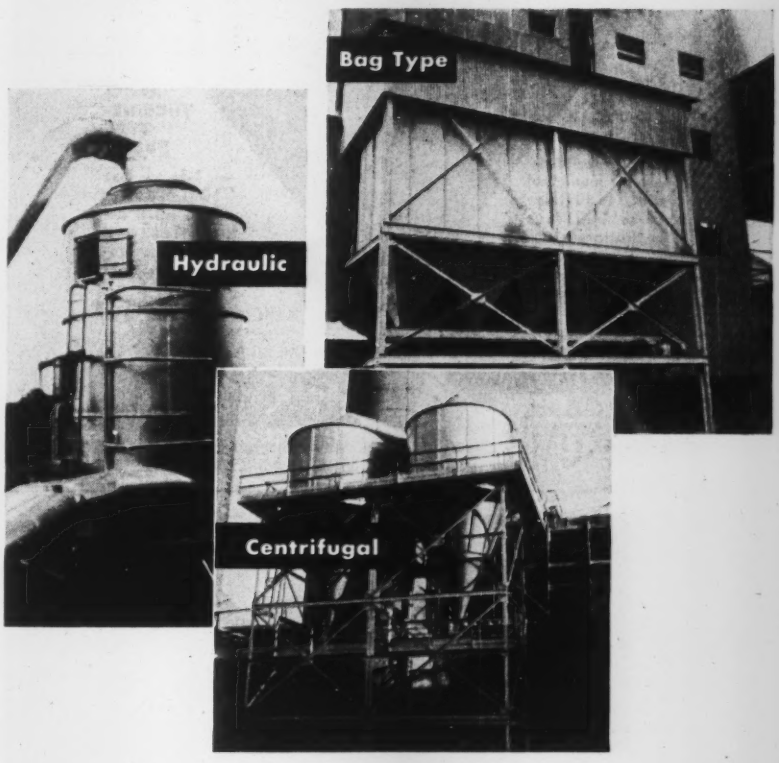

and salvage valuable elements economically!

Dust and fume collection fits into processing and manufacturing *in a big way*. Norblo has helped to implement this valuable aid to safety, health and economy in a big way with outstanding developments in three principal types of collection — Centrifugal, Hydraulic and Bag systems.

Norblo Systems are making new records for high recovery with low operating and maintenance costs. High-efficiency equipment is engineered to include the correct factors to suit your needs and carries the Norblo guarantee of performance. Get the facts on Norblo Dust and Fume Collectors before you decide on any dust or fume collection equipment.

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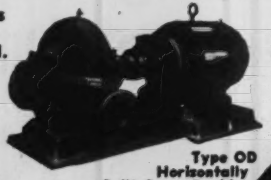

Capacities to 4,000 G.P.M.

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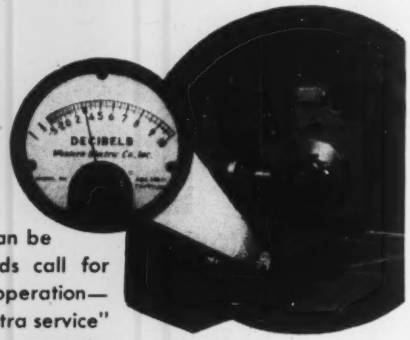
there's a *db in gears



*Decibel (db) tolerances in gears can be important—and if your gear needs call for minimum db tolerances—for *silent* operation—you'll be interested in the unique "extra service" offered by The Cincinnati Gear Company: scientific sound inspection. Each gear you order can be individually *sound-checked* with modern electronic testing equipment for the most exacting noise limits, under a specified load and RPM. No guesswork—the *exact* decibel noise ratio is registered on the dial pictured—your assurance of truly silent gear operation. Inquire today for complete details.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Westinghouse to Build Meter Plant

Ground-breaking ceremonies for the Westinghouse Electric Corporation's new $10 million meter plant at Raleigh, N. C. were held recently. The new plant will manufacture watthour meters.

Erection of the new plant, which will consist of two buildings with an interconnecting wing, is scheduled to begin about March 1, and installation of the meter socket production department will begin in late July or August. The first meter is expected to be in production late in 1953.

The one-story plant, of brick and corrugated asbestos construction will be 1020 ft × 420 ft. The two-story brick office building will be 460 ft. × 80 ft, while a connecting one and two-story wing between the office and plant will be 180 ft. × 80 ft. The second story of the wing will house office-conditioning apparatus and engineering laboratory generating equipment. The building project will provide approximately 500,000 sq. ft. of floor space.

Latest Catalogs

Mass Spectrometer

Bulletin CEC-1800B, issued by Consolidated Engineering Corp., Pasadena 15, Calif., describes the Consolidated model 21-103A mass spectrometer. Its uses for control analyses, complex mixture analyses, exploratory analyses, purity determinations, and research investigations are pointed out.

Speed Reducers

A catalog issued by D. O. James Gear Mfg. Co., 1140 W. Monroe St., Chicago 7, Ill., contains informative engineering data and prices that should assist in the selection of the proper gear reduction unit for specific power-transmission problems. The catalog has the following three subdivisions: motorized gear speed reducers, motor reducers, and gear speed reducers.

Industrial Fans

Eleven sizes of new industrial fans and their standard wheels are fully described in a new 12-page booklet available from the Westinghouse Electric Corporation's Sturtevant Div. The booklet deals with fans which range in size from 670 to 44,000 cfm at pressures up to 16-in. mercury. In addition to presenting a table of condensed specifications on performance and dimensions, the booklet discusses each of the three available wheel types — air handling, material handling, and long shavings — and gives typical applications for each. Also, arrangements in which the fans may be obtained are shown and described. Accessories available and special features are also pointed out and fully discussed. To aid in the selection of a fan for high-temperature applications, a table of maximum operating rpm's for various fan sizes and operating temperatures is presented.

For a copy of this booklet, SA-6873, write Westinghouse Sturtevant Div., Dept. T-415, 200 Readville St., Hyde Park, Boston 36, Mass.

Keep Informed

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Precision-Bored Tubes

Bulletin No. 1701, just issued by the Piping Dept., Dravo Corp., Dravo Building, Pittsburgh 22, Pa., describes the advantages to be gained by installing precision-bored tubes in connection with flowmeter orifices. The precision-machine-bored meter run gives standardized performance of measurement and permits the use of any beta ratio.

Rubber-Lined Process Pumps

A four-page, two-color bulletin, No. WQ-212, is devoted to rubber-lined centrifugal chemical and process pumps. Designed and built especially for handling hydrochloric and other strong acids and corrosive salts. Bulletin includes specifications, dimensions, sectional and external views, etc. Available from Warren Steam Pump Co., Inc., Warren, Mass.

Vacuum Uses

"Vacuum—the Magic Hat of Industry," is the title of a 12-page magazine reprint, Form 164, available from Ingersoll-Rand Co. This article reprinted from *Compressed Air Magazine*, is written in simple, non-technical language and describes the many varied uses of vacuum throughout industry. It also discusses the methods of making a vacuum. Included are two full-page charts on vacuum uses and manufacture. Available from Ingersoll-Rand, 11 Broadway, New York 4, N. Y., or any branch office.

Automatic Lubrication

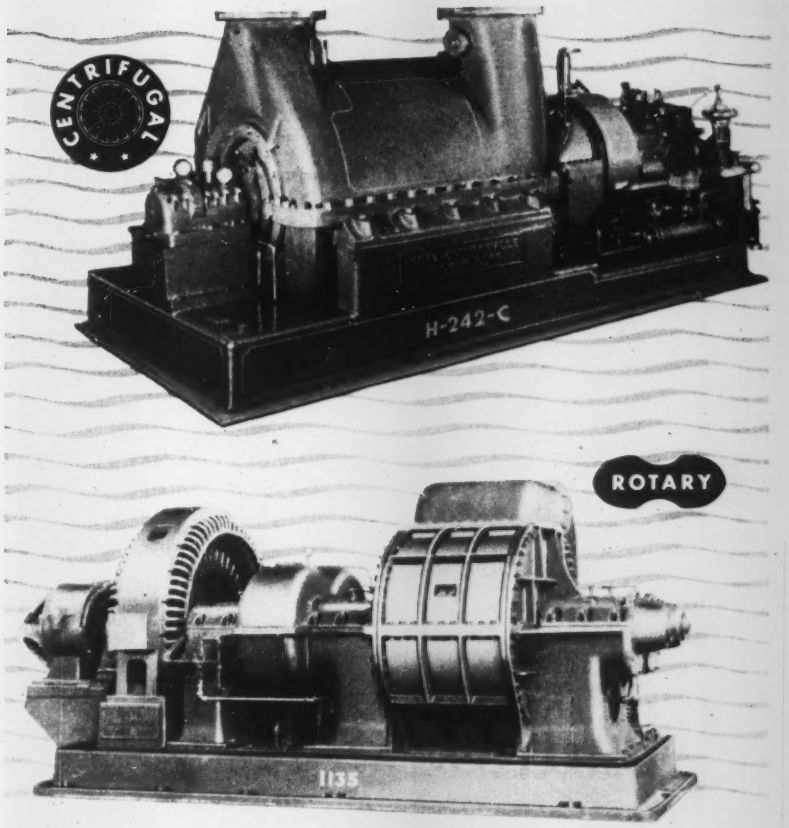
A 4-page two-color illustrated folder, published by Trabon Engineering Corp., 1814 E. 40th St., Cleveland, Ohio, gives pertinent sales points about the application of patented Trabon automatic lubrication systems. Includes engineering description of technical methods of operation, in the case of both Trabon's reversible and manifold types of lubrication systems. This general bulletin 529 will be useful for anyone interested in the proper planning and engineering of centralized lubrication.

Finned Coils

The Bush Mfg. Co. of West Hartford, Conn., has issued a catalog covering their complete line of finned coils. Included are water, direct expansion, and steam (both standard and nonfreeze) coils. Featured in the catalog are Bush pre-engineered coils—coils in stock sizes rated at standard conditions. The catalog contains specifications on all types of Bush coils as well as engineering and construction data which simplifies specifying and ordering.

Boiler-Burner Unit

A new 12-page booklet, illustrated in color, issued by Iron Fireman Mfg. Co., Cleveland, Ohio, and Kewanee-Ross Corp., Kewanee, Ill., describes a boiler-burner unit for high or low-pressure heating, power, and process steam. Uses either oil, gas, or oil-gas combination. Available for high-pressure steam in sizes with outputs ranging from 52 to 456 hp, 125 and 150 lb working pressure; also for low-pressure 15 lb steam or 30 lb water, in sizes from 1,313,000 Btu to 10,200,000 Btu.



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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Inspirators and Boosters

A new catalog No. 806A, issued by Hauck Mfg. Co., Brooklyn, N. Y., describes latest improved type and sizes of high-pressure gas-air inspirators and boosters for industrial furnaces, ovens, kilns, driers, etc. The major features of the new design are as follows: maximum entrainment, streamlined flow and better control of induced air; an easily adjustable air shutter with a fiber pad under the locking thumbscrew; dirt in atmosphere has less effect on the shutter; less space is required for a more compact installation.

Oil Field and Pipe-Line Equipment

A new 20-page bulletin, GEC-926, on equipment for the generation, transmission, distribution, and utilization of electric power in oil-field and pipe-line applications is available from the General Electric Co., Schenectady 5, N. Y. The bulletin briefly discusses operational problems of deep-well drilling and oil-well and pipe-line pumping and points out features of General Electric apparatus and electronic equipment recommended to meet specific needs. Also included in the well-illustrated manual are charts, tables, graphs, and product photographs to aid the reader in selecting the proper motors, control, transformers, switchgear, etc., for his individual requirements.

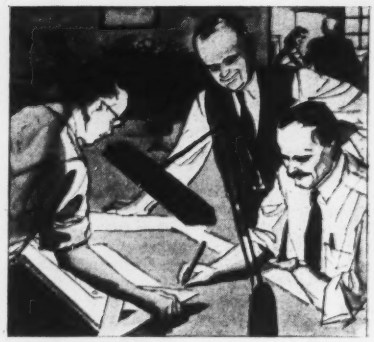
M-G Sets

Engineered motor-generator sets for all industries form the subject of a new 4-page illustrated bulletin, F-2502 issued by the Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland, Ohio. Briefly described is the complete line of "custom-tailored" M-G Sets—shunt or compound wound, from $\frac{3}{4}$ to 1000-kw—built by Reliance to provide power for constant-voltage or adjustable-voltage systems and engineered to include synchronous or induction motors. Also included are six typical applications of Reliance M-G Sets showing their utilization for large single-motor drives, excitation of synchronous machinery, multimotor drives, and "spot conversion," an economical means of supplying d-c power at the point of use.

Industrial Turbine-Generators

A 20-page booklet illustrating some 30 applications of "Industrial Turbine-Generators" is available from Westinghouse. Because requirements vary from applications where maximum conversion of heat energy to electrical power is most important to those in which process steam is of primary concern, the booklet describes the six principal types of industrial turbines. They are: noncondensing, noncondensing single extraction, noncondensing double-extraction, condensing single-extraction, condensing double-extraction, and condensing. The characteristics of each are described in terms of the electrical power and process steam each is capable of delivering, the remainder of the booklet presents photographs and installation data on representative turbine applications in the textile, manufacturing, metals, paper, petroleum, lumber, chemical and process, and food industries.

This booklet, B-5418, is available from Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa.



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you can profit from this challenge

If you're an experienced methods or process engineer who's looking for a change that spells c-h-a-l-l-e-n-g-e, one of many big openings at Honeywell might fit you.

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MINNEAPOLIS Honeywell

H HONEYWELL

First in Controls

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New Equipment | Business Notes | Latest Catalogs

Button-Head Screws

Standard Pressed Steel Co., Box No. 558, Jenkintown, Pa., has brought out a four-page, two-color bulletin on its new line of Unbrako button head socket screws. The bulletin cites the advantages of the button head, including threads to head, low-head height, non-slip drive, safety socket without burrs, concentricity of heads and threads, class three thread fit. Also included in the bulletin is a listing of the seven standard diameters of Unbrako button heads available in various lengths—Numbers 8 on 10 and 1/4 in., 5/16 in., 3/8 in., 1/2 in., and 5/8 in.—and the vital dimensions of each size, prices per hundred and the quantity included in each box.

Profilometer Equipment

A 24-page illustrated catalog of Profilometer equipment for shop measurement of surface roughness is announced by Micrometrical Mfg. Co., 345 S. Main St., Ann Arbor, Mich. This catalog first gives an over-all view of the Profilometer line. Subsequent sections cover amplimeter equipment, tracers, manual and motor-driven piloting equipment, and equipment in development. Each item is described in detail and shown in use, and complete, specifications are included. The catalog also lists typical combinations of Profilometer equipment most commonly selected for various job requirements.

Grommet V-Belt

The "Texrope" grommet v-belt, for which 20 to 50% longer life is claimed, is described in a new Allis-Chalmers bulletin. The "Texrope" grommet v-belt is the only belt made without a splice. According to the bulletin, it is cooler running, is shock absorbent, has one-tenth the shrinkage and one-third the stretch of other belts, offers less slip and more grip, and is 20% stronger. Cross-section illustrations show how the "Texrope" grommet v-belt provides a higher gripping pressure under all load conditions. Copies of the bulletin, " 'Texrope' Grommet V-Belts," 20B-6497A, are available from Allis-Chalmers Mfg. Co., 949 S. 70th St., Milwaukee, Wis.

Spray Nozzles

Bulletin 6-A, issued by Schutte and Koerting Co., contains complete technical details on the line of atomizing and spray nozzles #3 manufactured by the company. Atomizing nozzles, spray nozzles, and spray nozzle clusters are treated in separate sections of the bulletin. Information given for each type of spray nozzle includes: construction details, spray characteristics, and capacities. Dimension tables, capacity charts, and drawings supplement text material. Copies of Bulletin 6-A are available from Schutte and Koerting Co., Dept. J-K, Cornwells Heights, Bucks County, Pa.

Industrial Meters

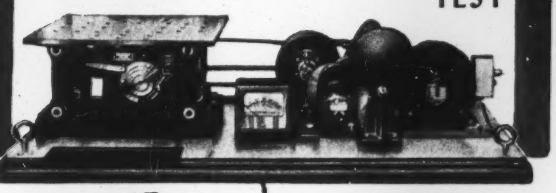
A bulletin, No. OG-403, describing its new corrosion-resistant stainless-steel industrial meter has been issued by Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa. Special reference is made to the value of the meter in the handling of corrosive liquids common to the cellulose, chemical, confectionery, food, oils and fats, rubber, pharmaceutical, and industrial processing fields. Emphasis is placed upon the meter's maximum capacity of 100 gpm at a maximum working pressure of 125 psi. Information is also included on registers, register weights, units of measurement, materials and meter weight. Complete meter and register dimensions are also shown.

Precipitator for Paper Industry

A new 4-page bulletin with conveniently arranged information for a quick understanding of the special design features of the Cottrell electrostatic precipitator for the paper industry, has been announced by Research Corp., Bound Brook, N. J., manufacturer of Cottrell electrostatic equipment. The wet-bottom design that reduces time and costs in handling precipitated material, which is a recent development by Research Corp., is also explained in the new bulletin. Diagram and complete cutaway view of the equipment shows operating and construction details.

Give Parts, Assemblies a Positive

VIBRATION TEST



ALL AMERICAN VIBRATION FATIGUE TESTING MACHINE

Model 100 HL-A
Capacity 100 lbs. Produces vibrations horizontally. New 4-point linkage arm table support.

NATIONAL Bureau of Standards uses four, Mass. Inst. of Technology two, Western Electric 13, Westinghouse and G. E. 12 each. Basic equipment for YOUR testing laboratory or inspection department. In many plants a laboratory in itself. Detect excess weight—find structural weak spots.
For electronic, automatic, aircraft, crystal, optical and instrument makers, schools and research laboratories. Models to test parts from a few ounces to 100 lbs. Choice of horizontal or vertical table movement. Frequencies of 600 to 3600 v. p. m. Automatically or manually controlled. Send for Catalog F.

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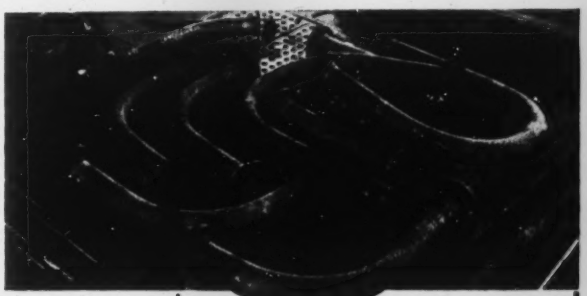

10" chrome alloy pipe bends with chrome welding neck flanges.

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With WPS sub-assemblies, field welds are minimized; each job is engineered and built to *exact* specifications.

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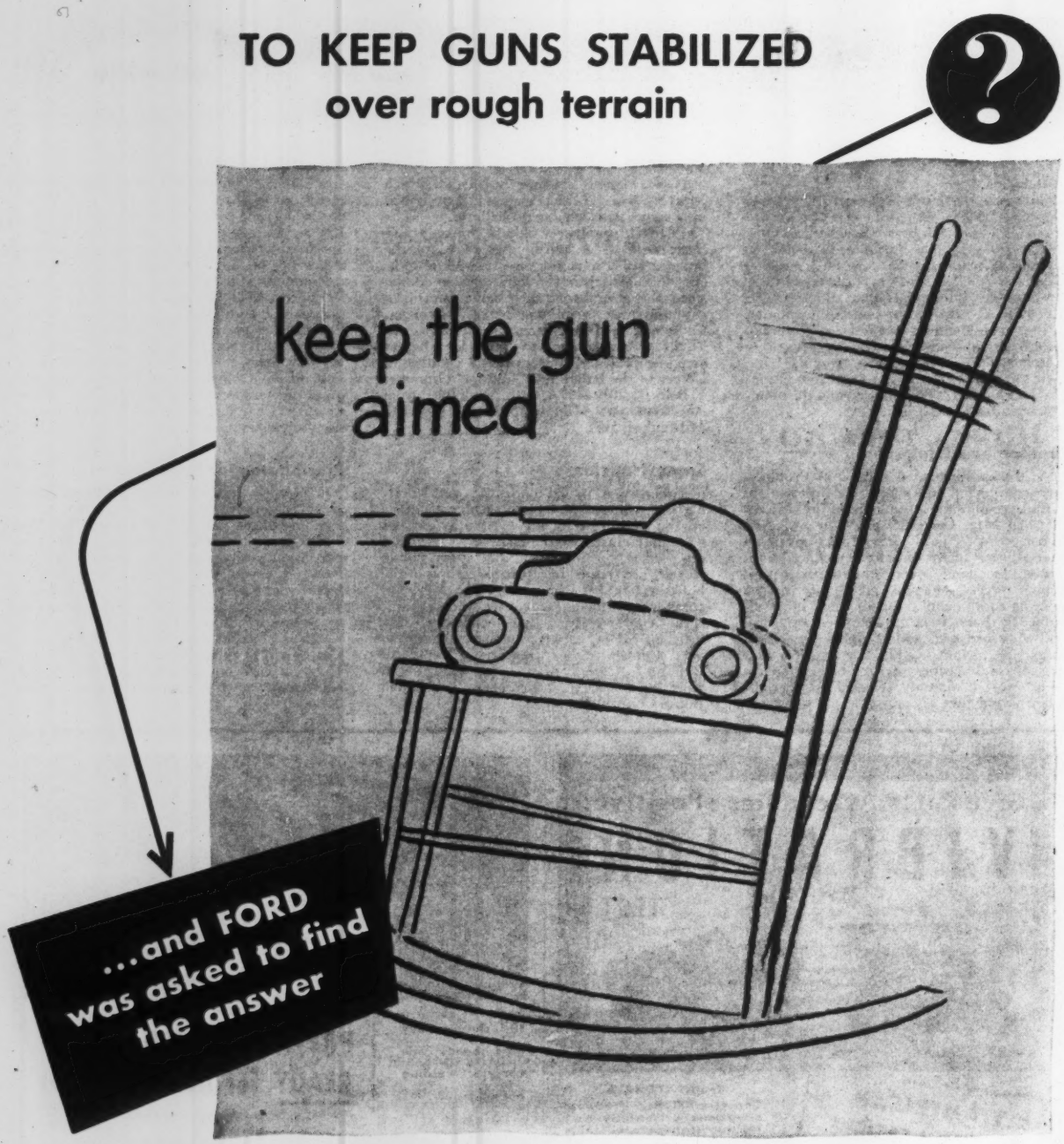
over rough terrain



Over open area a tank pitches and heaves like a rocking chair . . . but regardless of the bumps . . . ditches . . . hills . . . the guns keep pointing at the target while the tank is moving. Ford Instrument Company played a vital role in designing and manufacturing a stabilizer unit for the tank's gun fire control system.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.

You can see why a job with Ford Instrument Company offers a challenge to young engineers. If you qualify, there may be a spot for you in automatic control development at Ford. Write for illustrated brochure.

7

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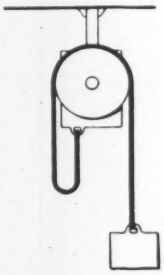
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

TENSION LINKAGE

WHAT'S THAT?

Some designers have been asking us what we mean by the term "tension linkage." We use it to describe any chain application in which the linear movement of the chain is not continuous in direction. The predominant feature of a tension linkage application is that the chain need not be formed as an endless chain belt.

There is a wide variety of possible tension linkage applications.



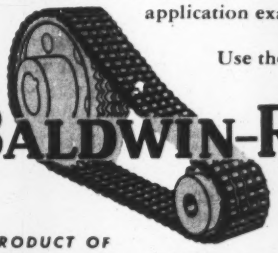
here's one example

Suspension of the load on a chain hoist. The load is lifted or lowered by the rotation of the sprocket. One end of the chain is permanently anchored as indicated. The free end is fastened to the object to be lifted or lowered. The sprocket is driven by hand power or motor power through gearing. The slack side of the chain usually hangs freely, thus providing 180° wrap on the sprocket.

here's another one

Reposition of a shaft that has been rotated through a limited angle. The shaft is turned clockwise (as shown in the illustration) during some operation of the associated equipment. The resulting compression of the spring provides the energy necessary to return the shaft to its original position. In many cases of this type, operation is frequent and high shock loads are encountered, so *chain* is the answer.

Our Bulletin No. 51-10 contains complete details on why Baldwin-Rex® Roller Chains, Leaf Chains and Block Chains are ideal for tension linkages. It also contains application examples and tables of weights, strengths and dimensions. Use the coupon to send for it today.



BALDWIN-REX®

ROLLER CHAINS

A PRODUCT OF

Chain Belt COMPANY

OF MILWAUKEE

Chain Belt Company 52-401T
363 Plainfield Street
Springfield 2, Mass.

Gentlemen:
Please send me Bulletin 51-10.

Name.....

Company.....

Address.....

City.....*State*.....

TRAILMOBILE

RADIUS ROD JOINTS *by* LORD

Look at the Trailmobile radius rod joint shown in close-up at the left. This Lord high performance center-bonded-rubber joint .....

1. Saves manufacturing and maintenance cost,
2. Absorbs the shocks of braking-loads and road irregularities imposed on the radius rods,
3. Provides necessary articulation.

When axle inspections require removal or replacement of radius rod joints, a simple arbor-press operation shortens loss of payload time and reduces actual repair cost. We invite you to avail yourself of our experience in designing and manufacturing precision bonded-rubber parts.

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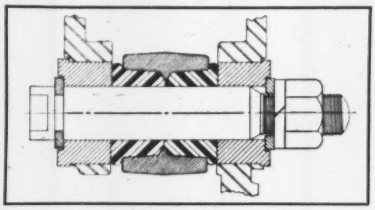
LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER — *Headquarters for* VIBRATION CONTROL

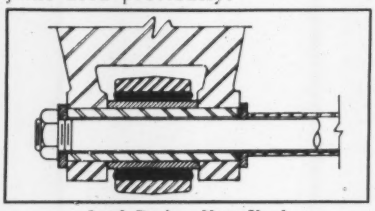
Lord Bonded Rubber Improves Radius Rod Joint on Trailmobile

Trailmobile, Inc. at Cincinnati, Ohio, believed that maintenance costs on their suspension systems could be reduced by redesign of the radius rod rubber bushings. When their standard radius rod had to be disconnected for maintenance of the suspension, often it was necessary to replace a number of parts of the radius rod rubber bushing assemblies.



Old Design

Lord engineers worked with the designers at Trailmobile to arrive at a rubber joint design that permits making an almost limitless number of disconnections of the radius rods without requiring replacements of the rubber joints, requiring only the time needed to remove the pin through the joint and bracket. The Lord Center-Bonded Joint, now standard in new Trailmobile assemblies, not only fully satisfied requirements, but did so with fewer and simpler parts, *and* at a cost lower than that of the unbonded rubber joint used previously.



Lord Design Now Used

Now when it becomes necessary to remove the Trailmobile Radius Rod it is a simple, easy operation to drive the pin from the hanger. When new bushings are necessary the old ones are pressed out and new ones installed with an arbor press.

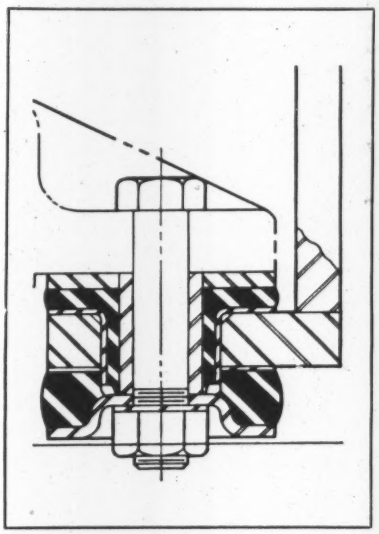
Improvements of this nature are being designed into a wide diversity of automotive and industrial products as the result of cooperative efforts of Lord Engineers and the Design Engineers of such product manufacturers. Precision manufacture is the added ingredient which gives Lord Engineering its high value to industrial designers.

Lord Mountings Cut Service Costs on Ready-Power Units Used by Industry

The most efficient mounting system for Ready-Power "Live Power" units necessitates the isolation of engine vibration, the accommodation of frame twist and absorption of shock loads encountered in industrial materials handling.

Because of limited space the mountings must be sufficiently rigid to prevent excessive engine-generator motion yet flexible enough to isolate engine vibration and absorb shock loads which seriously damage engine brackets, oil lines and other component parts. These shock loads are caused when industrial trucks bump into pallets or solidly packed storage areas or are operated over unusually rough and bumpy surfaces.

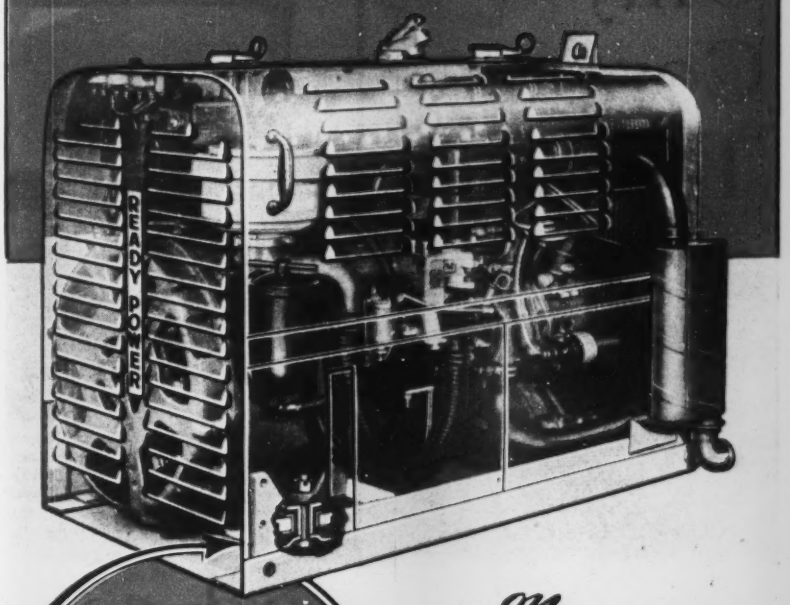
DuPont Neoprene is used as the base in the compound specifically designed by Lord to meet the deteriorating effects of oil, gasoline etc.

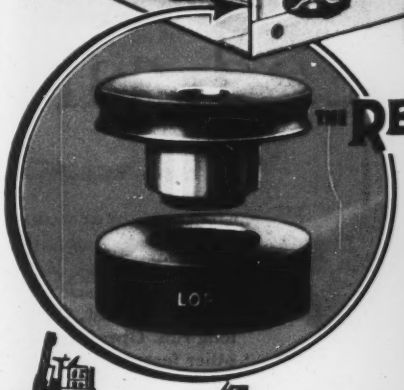


This Lord mounting is designed for easy installation, no extremely close tolerances being involved. The Ready-Power representatives maintain close contact with their equipment under all operating conditions. They report that the use of Lord mountings minimizes maintenance and service formerly the result of shock and vibration.

Further details on this and other successful handling of vibration and shock problems are available on request from Lord Manufacturing Company, Erie, Pa.

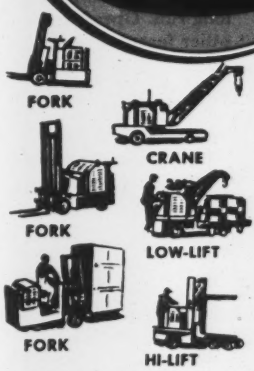
LORD MOUNTINGS
SERVE DUAL PURPOSE





on THE READY-POWER CO.
"Live Power Units"

LORD Shock Mountings accomplish two vital objectives in the delivery of "Live Power" generated as needed directly on the truck chassis of industrial fork trucks, tractors, cranes and locomotives by Ready Power Units.



1. The upper Lord Mounting J-4497-2 absorbs the unusually high "g" shock loads encountered in industrial lift truck service . . . At the same time it is rigid enough to prevent excessive engine motion due to these destructive shock loads.

2. The lower member J-4591-1 is a rebound snubbing washer thicker than the sandwich section of the upper member J-4497-2. Precompression thus allows variable bracket thickness of plus or minus 1/16 inch. Thus the Lord Mountings serve the dual purpose of minimizing the vibration and the multiple shocks to which Ready-Power units are subjected in powering the heavy tools of industry. You can profit by Lord experience in the control of vibration and shock. Write or call . . .

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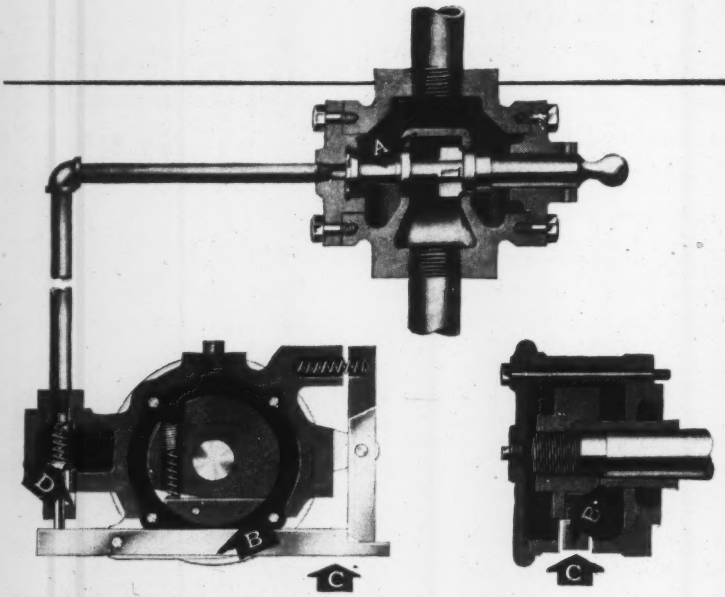
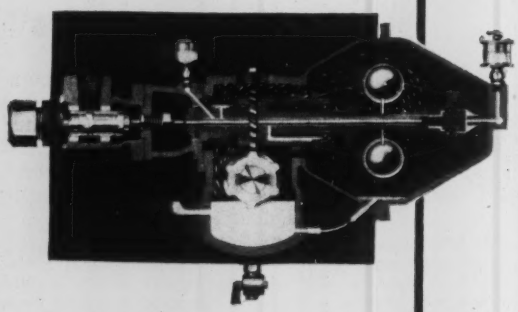
LORD MANUFACTURING COMPANY • ERIE, PA.

LORD BONDED RUBBER
Headquarters for
VIBRATION CONTROL

Only Coppus Turbines offer you *a pilot operated* excess speed safety trip



The constant speed governor on Coppus Turbines, plus this Excess Speed Safety Trip, gives you extra protection for your turbine investments. Here's how it works. When steam is turned on, pressure opens valve A fully. When excess speed is reached, centrifugal force throws weight B against lever C lifting pilot valve D. This releases pressure in back of valve A, closing this valve instantaneously, to shut off the steam. Safety trip can be tested easily while turbine is running by manually tripping and resetting lever C.



Sectional view showing lubricating system of fully enclosed Coppus Constant Speed Governor. Governor head acts directly on stem of steam admission valve. No external levers required. Ball bearing construction eliminates end play and gives frictionless operation.

Coppus Turbines ranging from 150 hp down to fractional in 6 frame sizes

CUT YOUR COSTS PER HORSEPOWER

When you choose from the Coppus Steam Turbine line, you get the right size for your requirements . . . and make substantial savings on *any* size from the 150 hp turbine down to the smallest. Low in first cost, Coppus Turbines save you more money in the long run. Operating and maintenance costs are kept low by such other features as: large number of steam nozzles, controlled individually by manually operated valves; hard chromium plating on shaft at the stuffing box; replaceable cartridge type bearing housings; optional carbon ring packing assembly for back pressures up to 75 pounds.

WRITE FOR BULLETIN 135

COPPUS ENGINEERING CORPORATION, 362 Park Ave., Worcester 2, Mass. Sales offices in THOMAS' REGISTER.

COPPUS "BLUE RIBBON" TURBINES

Remember — the trade marks "tt" and "TUBE-TURN" are applicable only to products of TUBE TURNS, INC.

Engineered

FOR MINIMUM PRESSURE DROP

THIS TUBE-TURN Welding Elbow has full radius conforming to A. S. A. Standard B 16.9. The radius is not reduced by tangents. The interior walls are consistently smooth and perfectly circular . . . important production features which minimize pressure drop.

This attention to engineering detail pays off in your piping systems. When you specify TUBE-TURN Welding Fittings and Flanges, pressure drop is at a minimum and uniformity of fit-up is assured.

You'll find a TUBE TURNS' Distributor in every principal city. Call him for good service in good connections.

Be sure you see the double "tt"

TUBE TURNS, INC. LOUISVILLE 1, KENTUCKY

DISTRICT OFFICES: New York • Philadelphia • Pittsburgh • Chicago • Houston • Tulsa • San Francisco • Los Angeles

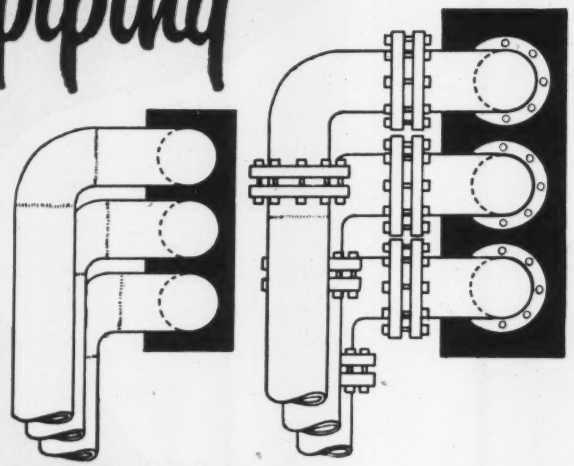
Wholly owned subsidiaries: TUBE TURNS OF CANADA LIMITED, CHATHAM, ONTARIO

PENNSYLVANIA FORGE CORPORATION, PHILADELPHIA, PA. • KEROTEST MANUFACTURING COMPANY, PITTSBURGH, PA.

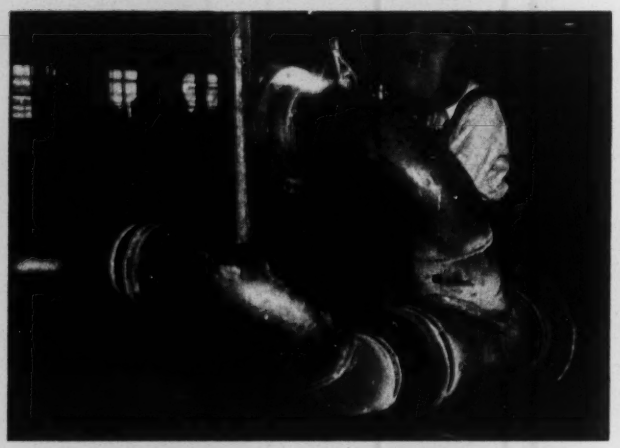
COMPACT *Welded piping* SIMPLIFIES THE JOB

You can simplify design, save valuable space and speed up the piping job by specifying *welded construction* with Tube-Turn Welding Fittings. Welded joints are virtually flush with the pipe. Pipes can fit snugly together in tight corners . . . against wall or ceiling . . . or around equipment. And welded piping requires little elbow room to install . . . and to insulate. The true circularity and uniform wall thickness of Tube-Turn Welding Fittings simplifies fit-up and assures a job well done under crowded working conditions.

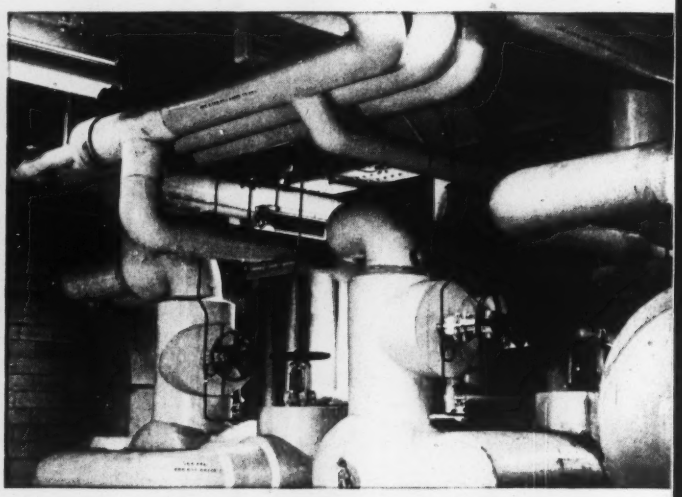
This is just one reason why it pays to specify *welded piping*. It's stronger, lighter, streamlined, economical to install, insulate and maintain.



Example: **The welded assembly on left takes a third less space than comparable flanged assembly.**



Bring on your tight corners! Entire sections of welded piping can be shop-fabricated and erected as a unit with a few simple tie in welds or flange connections to valves or containers.



In the new O. H. Hutchings Station of Dayton Power & Light Company. Piping for deaerators and feed water heaters is compact, streamlined and permanent. Directional changes are made with TUBE-TURN Welding Fittings.

TUBE TURNS, INC., Dept. F-2
224 East Broadway, Louisville 1, Kentucky

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Position _____

Company _____

Nature of business _____

Address _____

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"TUBE-TURN" and "TUBE-TURN" Reg. U. S. Pat. Off.

TUBE TURNS, INC.

LOUISVILLE 1, KENTUCKY

BROOKLYN was "unprintable"

Recently, The Consolidated Edison Company (in New York City) faced this problem: It had to produce a direct-process print from each one of more than ten thousand Brooklyn Underground Record Maps, showing the distribution system of electric service.

But satisfactory prints could not be produced directly from these maps. They were up to 30 years old . . . had been referred to constantly . . . and as a result were soiled, stained, creased, and "dog-eared."

What to do? Retracing was out of the question, since it would take a draftsman from two to three days to trace and check just one of these 17″ x 25″ drawings.

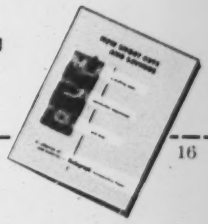
Kodagraph Autopositive Paper was the speedy, economical solution

With this revolutionary photographic intermediate paper, approximately 40 sharp and clean "duplicate originals" could be turned out in an hour. *Yes, 40 in an hour* because Kodagraph Autopositive Paper produces positive copies directly—without a negative step, without darkroom handling. At the same time, it drops out stains, creases . . . cleans up backgrounds . . . transforms weak detail into dense photographic black lines. Furthermore, Autopositive Paper can be exposed in standard print-making equipment . . . and processed in standard photographic solutions.

Thus, Consolidated Edison obtained—*in record time and at minimum cost*—a complete set of duplicate originals, which were used to produce the required direct-process prints . . . and were then filed away for future reference work and print-making needs.

Kodagraph Autopositive Paper

"THE BIG NEW PLUS" in engineering drawing reproduction



16

Learn in detail all the ways you can save with Kodagraph Autopositive Paper—the revolutionary photographic intermediate material which you, or your local blueprinter, can process *quickly . . . economically . . . at low cost.* Mail coupon today for free booklet!

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N. Y.

Gentlemen: Please send me a copy of "New Short Cuts and Savings"... describing the many savings Kodagraph Autopositive Paper is bringing to industry.

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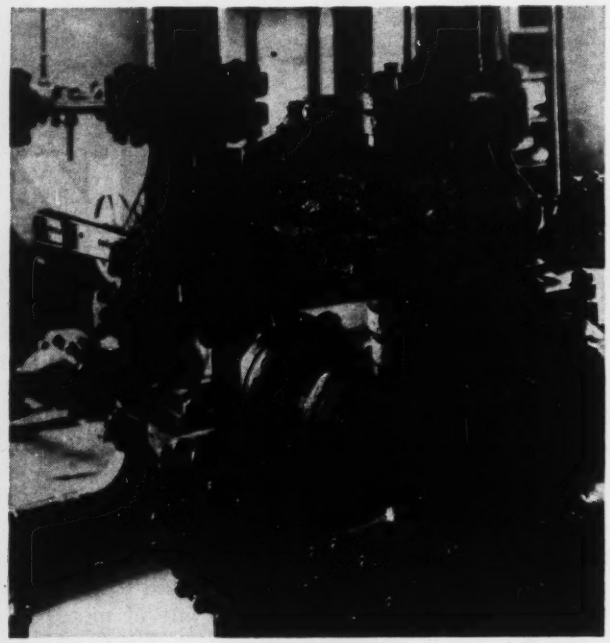
Kodak
TRADE-MARK

Four years maintenance-free service on Propane at 300 pounds pressure—temperatures from 60° F. above to 40° F. below zero . . .

. . . THAT KIND OF PERFORMANCE IS AN "OLD STORY" WITH . . .

HOMESTEAD *Lever-Seald* VALVES



Propane at 300 lbs. pressure, minus 40° F.

A prominent Mid-Western Oil Refiner* installed a 3", flanged, cast-steel, straightway HOMESTEAD Lever-Seald VALVE on Propane service at 300 lbs. working pressure with a temperature range from 60° F. above to 40° F. below zero. After four years service, with no maintenance except repacking, the valve still held tight.

That sold him—proved to him that HOMESTEAD Lever-Seald VALVES are his "best buy!" Today he is using Lever-Sealds on Propane and on drag lines from stills, another difficult service.

HOMESTEAD Lever-Seald VALVES really lick tough problems, not only in the Processing Industries, but in scores of other industries as well. And wise buyers know that savings effected on difficult services are made in even greater degree on "every day" air, steam, water, gas and oil jobs.

Why don't *you* prove to *your own* satisfaction that HOMESTEAD Lever-Seald VALVES are *your* "best buy," by putting some to work in your plant?

**Name on request.*

Drag line from still handling oil and tar at 800° F., 100 lbs. pressure.

For complete technical data and prices, WRITE FOR "VALVE REFERENCE BOOK No. 39." No obligation.

HOMESTEAD
VALVE MANUFACTURING CO.

P. O. BOX 38 ***"Serving Since 1892"*** **CORAOPOLIS, PA.**

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ILLINOIS GEARS Reg. U.S. Pat. Off

Gears for Every Purpose ... **one gear or 10,000 or more**

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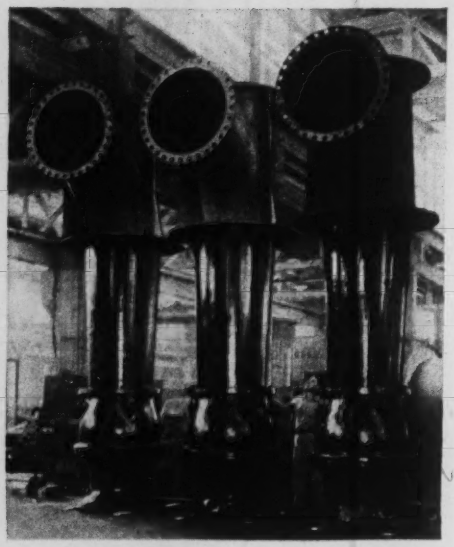
NOTES

for the engineer's note book

...ON
WHEELER-ECONOMY
POWER PLANT
EQUIPMENT



INCREASE OPERATING DEPENDABILITY WITH WHEELER-ECONOMY PUMPS

Wheeler-Economy Pumps Designed Particularly for Power Plant Application Include:

CIRCULATORS

Mixed Flow, Vertical Wet Pit, Standard and "Pull-Out" Types
Mixed Flow Volute, Dry Pit Type
Horizontal Double Suction

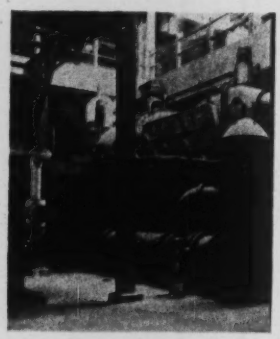
CONDENSATE PUMPS

Multi-Stage Horizontally Split Case
Vertical Barrel Type

36" mixed flow condenser cooling water circulating pumps (illustrated) ready for day-in day-out 24-hour service. These circulators have a capacity of 28,000 GPM at 45' head. Driven by 400 HP motors at 585 RPM. Circulators are offered in standard sizes from 1000 GPM to 100,000 GPM and may be furnished on special order for capacities up to 200,000 GPM.

Wheeler-Economy Pumps for General Service Power Plant Operation Include:

Single Stage High Head Double Suction; Multi-Stage Horizontally and Vertically Split Case; Process; Sump; Heating and Fire Service.



BE SURE OF PEAK PERFORMANCE WITH C. H. WHEELER CUSTOM-BUILT CONDENSERS

The thinking of C. H. Wheeler's experienced engineers is not confined to any standard or special type of condenser. They study all the conditions surrounding your requirements—such factors as source, quantity and quality of water supply, etc. The C. H. Wheeler Steam Condenser they subsequently recommend and design for you is, therefore, custom-built for every contingency that might arise. Initial cost is soon paid for and you enjoy the peace of mind that goes with sustained peak performance. Write for bulletin, "Self-Cleaning Steam Condensers with Reverse Flow."

GET MORE EFFICIENCY AT LOWER COST WITH C. H. WHEELER TUBEJETS

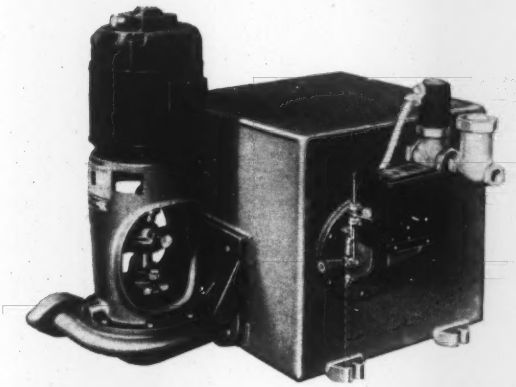
The C. H. Wheeler Manufacturing Company has been foremost in the development of steam jet ejectors, winning engineering awards and world-wide distinction in this field. The C. H. Wheeler Tubejet is a highly reliable vacuum pump. It is easy to install and maintenance costs are low. Long life is assured because the Tubejet has no moving parts. Tubejets are easily arranged in a variety of combinations of single or multi-stage units with inter- and after-condensers to meet all conditions. Write for CATALOG #1462.

C. H. WHEELER of Philadelphia

C. H. WHEELER MANUFACTURING CO., 19TH AND LEHIGH, PHILADELPHIA 32, PA.

Steam Condensers • Centrifugal, Axial and Mixed Flow Pumps • Steam Jet Ejectors • Cooling Towers • Vacuum Refrigeration
High Vacuum Process Equipment • Micro-Particle Reduction Mills • Marine Condensers and Ejectors • Deck Machinery

. . . ON
WHEELER-ECONOMY
HEATING PUMPS



SAVE COSTS IN HOT WATER OR STEAM HEATING

HOT WATER—Wheeler-Economy Hot Water Circulating Pumps can be furnished in a large range of types and capacities for economical, efficient use in panel, base board, radiant and all hot water heating systems.

STEAM—For steam heating systems, specify and use Wheeler-Economy Vacuum Pumps and Return Condensation Pumps to obtain top quality performance and reliability. You can count on an open system, free of condensate, at all times.

With Wheeler-Economy Heating Pumps on the job, savings in fuel, efficient BTU delivery and low maintenance pay you important dividends season after season. Our engineers and distributors will be glad to help you on pump specifications. Write for Bulletins on the extensive Wheeler-Economy Heating Pump line and location of nearest distributor.

(Note to Distributors: Some choice territories are still open.)

WHEELER-ECONOMY PUMPS

Division of C. H. Wheeler Mfg. Co.
Philadelphia 32, Pa.

. . . ON Klipfel
FLOAT VALVES

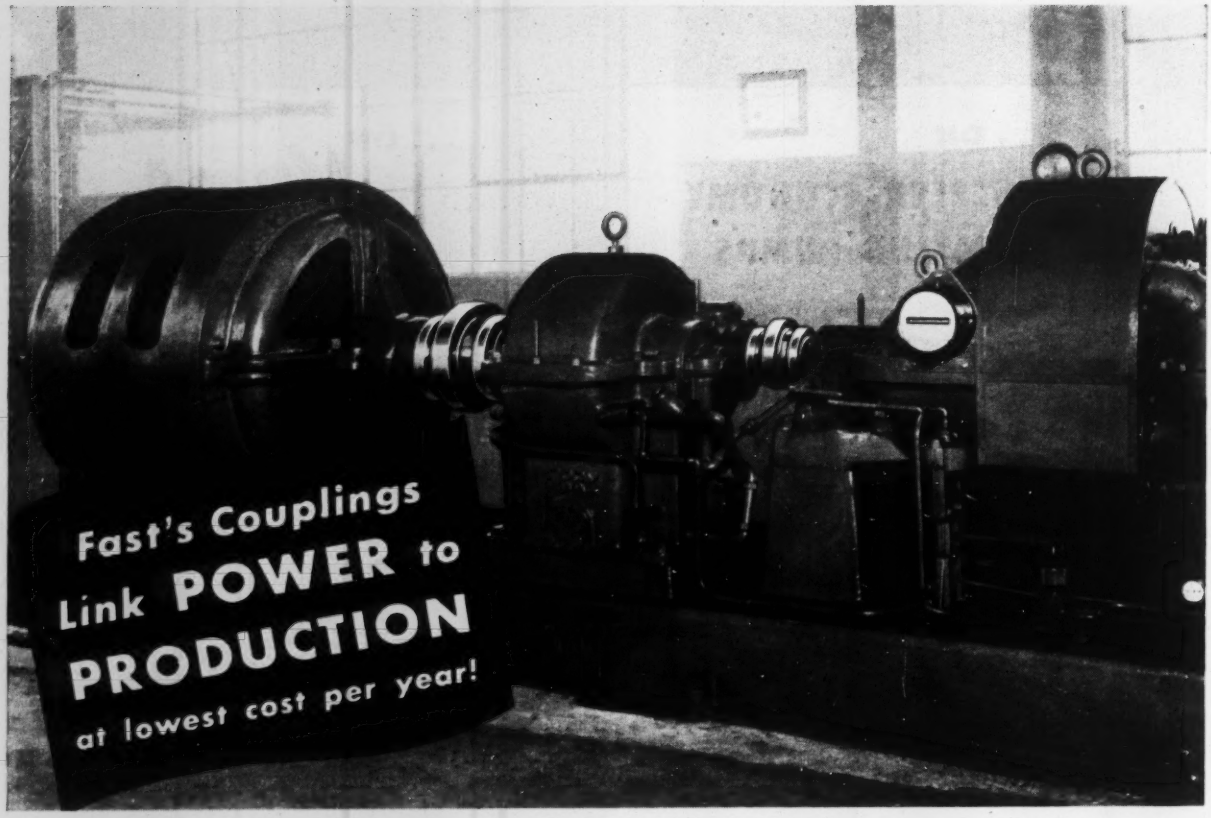
Klipfel WORRY-PROOFS YOUR LIQUID LEVEL CONTROL PROBLEMS

In many cases, you can save money by installing a good mechanical Klipfel Float Valve instead of an intricate, instrumentated controller. Your Klipfel Engineer or distributor can recommend Float Valves that literally "worry-proof" your liquid level control problems. To meet all requirements—pressure, temperature, type of fluid and closure—Klipfel Float and Lever Valves are made in 17 standard styles with a good range of sizes in each style. You can get a Klipfel Float and Lever Valve as small as ⅜" and as large as 12". Either direct acting or pilot control, and single or double seated types offer additional flexibility to meet any set of conditions.

Many thousands of installations—large and small—in water and chemical services—have proved the quality of Klipfel design and workmanship over the past 40 years. Write for **BULLETIN #349** which contains really useable information on the selection of float and lever valves.

Klipfel VALVES INCORPORATED

HAMILTON, OHIO



Every major producer of high-speed equipment uses FAST'S Couplings!

HIGH-SPEED equipment demands components with superior strength, accurate manufacture, long-lasting dependability. That's why it's important to *you* that Fast's Couplings are selected by every major high-speed equipment producer!

Fast's usually outlast the equipment they connect. Many have been in continuous operation for over 30 years, without trouble of any kind. And Fast's longer life saves you coupling dollars, too, because you amortize their cost over many years of trouble-free operation.

For full details on Fast's Couplings and Koppers Engineering Service, write today for your free copy of our catalog. Send to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 252 Scott St., Baltimore 3, Maryland.

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
252 Scott St., Baltimore 3, Md.

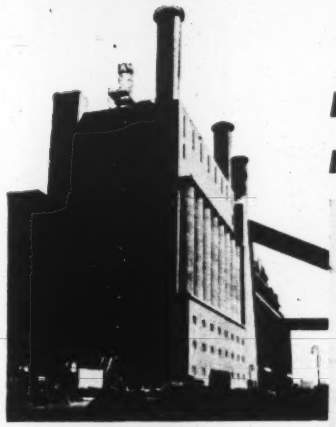
Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

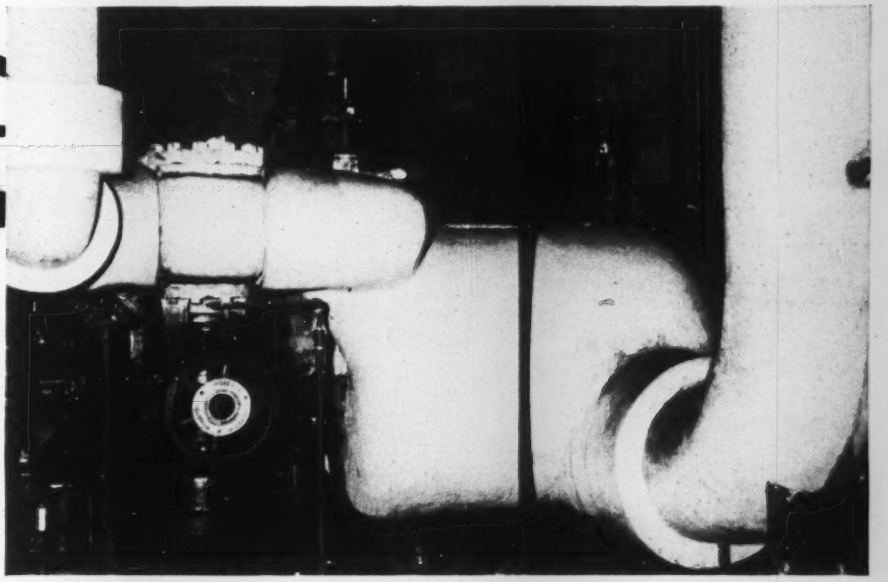
Company .....

Address .....

City ..... *Zone* ..... *State* .....



For this new addition to their New York City power plant at East River and 14th Street . . .



(Above) View of recently completed annex to Consolidated Edison's power plant . . . another link in their gigantic expansion program. **(Right)** Close-up of J-M 85% Magnesia Insulation on boiler feed lines. It was expertly installed by the Asbestos Construction Company, Inc., an outstanding J-M Insulation Contractor.

CON EDISON SPECIFIES J-M 85% MAGNESIA PIPE INSULATION FOR MAXIMUM FUEL SAVINGS

Like all materials that went into the new power plant addition of New York's leading gas and electric supplier . . . the pipe insulation had to be the *best*. That's why Consolidated Edison Co. specified J-M 85% Magnesia . . . industry's No. 1 insulation for many decades and *still* the leader in its class.

J-M 85% Magnesia is the leading insulation on the market for temperatures up to 600F. It is bonded with asbestos fibers. This rugged insulation will not distort regardless of the length of time it stays in service. J-M 85% Magnesia fits snug and stays put. Heat savings, therefore, remain constant for the life of the equipment on which this insulation is applied.

For temperatures over 600F, J-M 85% Magnesia is used in combination with Superex*, a J-M insulation for service to 1900F. This double-layer construction, known as Superex Combination, eliminates through joints and protects the jacket against scorching. It also utilizes the higher heat resistance of Superex next to the hot surface, and the greater insulating value of J-M 85% Magnesia for the outer layer.

*Reg. U.S. Pat. Off.

Experience has proved that all insulations must be properly installed to pay maximum dividends. That's why Johns-Manville offers industry the services of experienced insulation engineers and installation contractors who have made a career of solving complex insulation problems. From coast to coast, these engineers and the contractor's highly skilled mechanics stand ready to combine their talents and give you an insulation job that will more than pay off your initial investment with maximum fuel savings through the years.

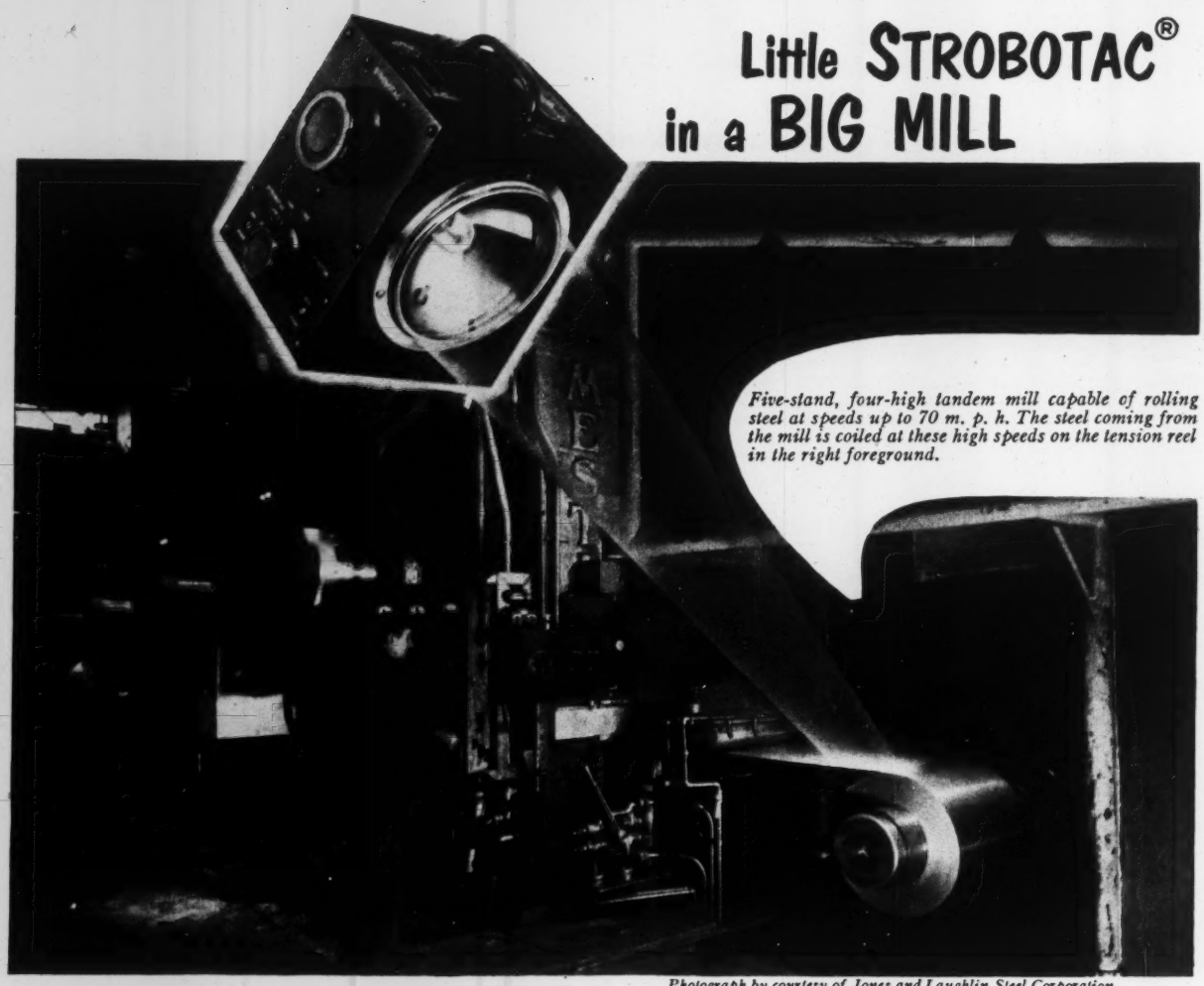
When you face your next insulating problem . . . remember that Johns-Manville is "Insulation Headquarters." Consult your near-by J-M Insulation Contractor . . . or write direct to Johns-Manville, Box 60, New York 16, New York. In Canada, write 199 Bay Street, Toronto 1, Ontario.

Skilled Applicators on the team of a J-M Insulation Contractor applying J-M 85% Magnesia to pipelines. Located throughout the nation, these contractors have had years of experience handling all types of installations. They know J-M 85% Magnesia and other J-M insulations as *quality* products, and take pride in applying them properly. Result: an insulation job that pays dividends through the years in maximum fuel savings.

Johns-Manville *FIRST IN* INSULATION

MATERIALS • ENGINEERING • APPLICATION

Little STROBOTAC® in a BIG MILL



Five-stand, four-high tandem mill capable of rolling steel at speeds up to 70 m. p. h. The steel coming from the mill is coiled at these high speeds on the tension reel in the right foreground.

Photograph by courtesy of Jones and Laughlin Steel Corporation.

Features

★ *Range — 600 to 14,400 rpm direct reading — can measure speeds up to 100,000 rpm — Type 631-BL measures from 60 to 1440 rpm*

★ *Only one control — knob calibrated in rpm adjusts flashing rate to desired value — dial reading accurate to ≏ 1%*

★ *Short, flash lasts 5 to 10 Millionths of a second — gives sharp images — rapid motion arrested without blurring*

★ *Means for standardizing flashing rate included*

★ *Inaccessible places can be readily reached for speed measurements or motion study*

★ *Ideal electrical type tachometer — no electrical or mechanical connections with motor — no power taken from device whose speed is being measured*

★ *DIMENSIONS — 7½ x 8¾ x 9⅞ inches*

★ *NET WEIGHT — 9½ pounds*

★ *ACCESSORIES SUPPLIED — Seven foot power cord, plug to fit contactor jack, and spare fuses.*

Type 631-B Strobotac $140

In the last ten years, the Strobotac has exerted a significant influence on progress in the mechanical and electrical industries. The steel rolling industry has benefited considerably from its use. With the aid of the Strobotac —

The ratio of slip between top and bottom rolls of Cold Reducing Mills can be readily checked

Recurring imperfections in steel being rolled at 70 mph are quickly detected

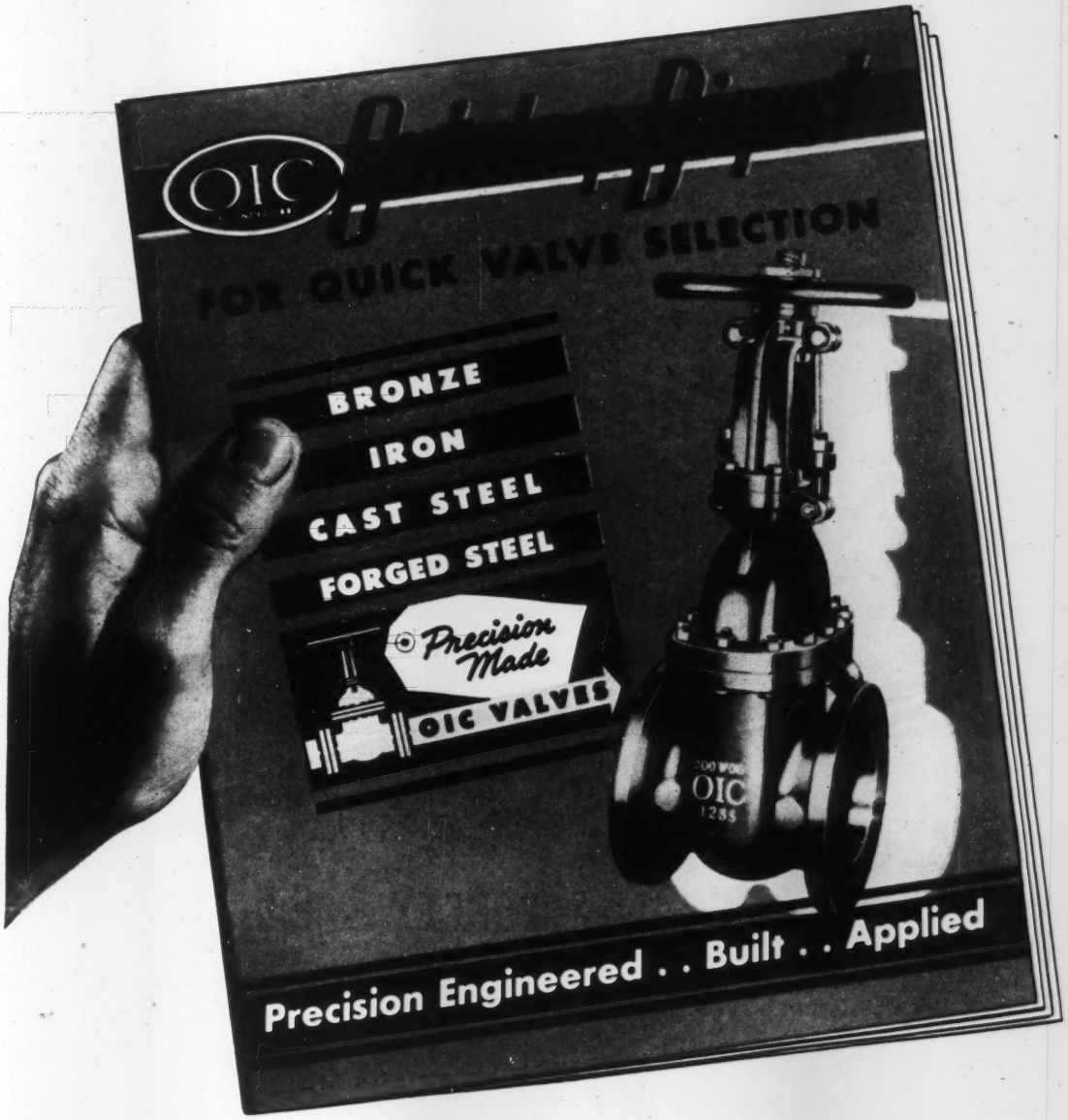
The operation of synchronous motors and other heavy equipment operating at high speeds is accurately controlled.

The illumination of moving objects with periodically-spaced light flashes permits unique study of high-speed motion. The "slowed" or "stopped" motion enables all irregularities to be seen — vibration, excessive torsion, chattering, whip or operation at incorrect speed is revealed. The Strobotac may be used to advantage in design, production, testing and in sales demonstrations. Time saved and results attained well justify the investment.

GENERAL RADIO® Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors
Decade Inductors ☆ Decade Resistors ☆ Distortion Meters
Frequency Meters ☆ Frequency Standards ☆ Geiger Counters
Impedance Bridges ☆ Modulation Meters ☆ Oscillators
Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls
Noise Meters ☆ Null Detectors ☆ Precision Capacitors
Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters
U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes



FREE . . to valve users and buyers

MAIL THIS COUPON TO . . .

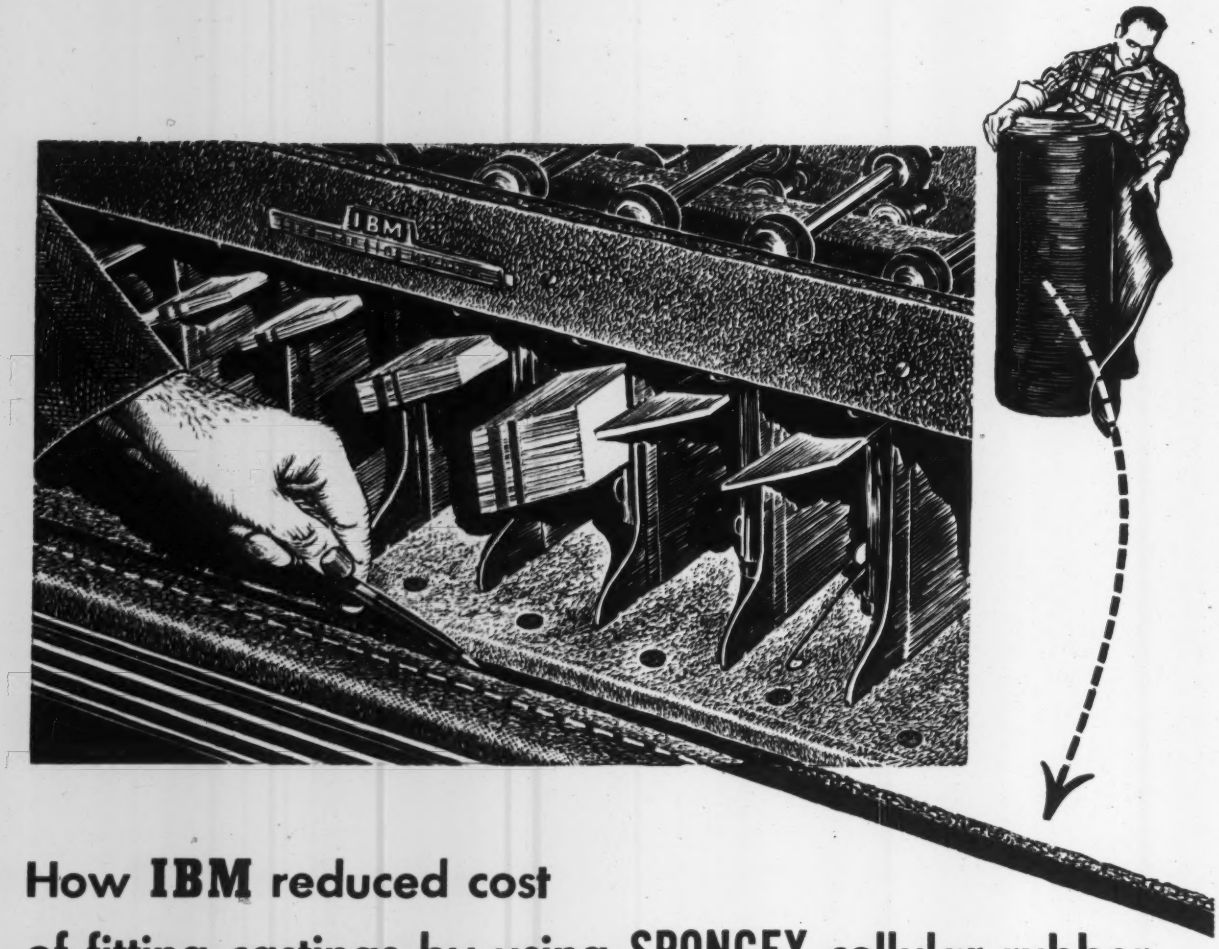
THE OHIO INJECTOR COMPANY
115 MAIN STREET
WADSWORTH, OHIO

Please send me a copy of the new booklet, "OIC Catalog Digest for Quick Valve Selection".

Name_____ Title_____

Company_____

Address_____



How IBM reduced cost of fitting castings by using SPONGEX cellular rubber

To get a perfect fit between the base casting and the apron on this card sorter, could be an expensive machining and fitting job. Instead IBM used an inexpensive strip from Spongex sheet stock to economically and successfully compensate for the surface variations of these metal parts.

Many production problems can be solved just as easily with an inexpensive form of Spongex. Gasketing, vibration damping, sealing, shock absorption . . . are only a few of the hundreds of applications of Spongex sheet stock.

You might cut your own needs from Spongex sheets and rolls. Or we'll die-cut to your specifications. If you want flame resistance, oil resistance, low temperature performance or high . . . there's a Spongex sheet stock compounded for the job.

SPONGEX® Cellular Rubber

for cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

THE SPONGE RUBBER PRODUCTS COMPANY 601 Derby Place, Shelton, Conn.

free Booklet

tells how to select pneumatic cylinders

• If you want a simple explanation of how to select pneumatic cylinders, send for a copy of our new 16-page booklet. It shows you how to determine the correct cylinder diameter, length of stroke, and type of mounting and lever system that will give you best operation. A table of performance data for each size cylinder enables you to order your cylinders right from this booklet.

Complete new line of pneumatic cylinders

• In addition to valuable application information, you get complete details about Westinghouse Air Brake Co.'s new line of cylinders. Completely redesigned, these cylinders are simpler and more rugged than previous models, and require less mounting space.

You can get these cylinders in diameters from 1½" to 10" with adjustable cushioning on 3" or larger diameters and with the stroke that you specify. They can be used in either air or hydraulic circuits. Send the coupon for complete technical information.

Westinghouse Air Brake Co.
Dept. ME-2, Industrial Products Div.
Wilmerding, Pa.

Please send me a copy of the booklet on your new line of pneumatic cylinders. I understand that it also contains some valuable application data.

Name.....

Company..... Title.....

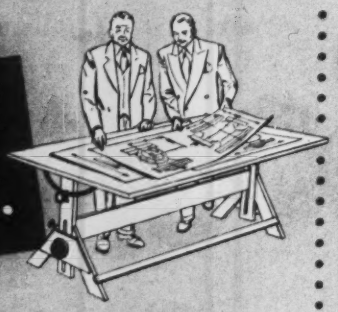
Address.....

City & State.....

Westinghouse Air Brake COMPANY

INDUSTRIAL PRODUCTS DIVISION WILMERDING, PENNA.

FACTORY BRANCH: EMERYVILLE, CALIF. IN CANADA: CANADIAN WESTINGHOUSE CO., LTD., HAMILTON, ONTARIO



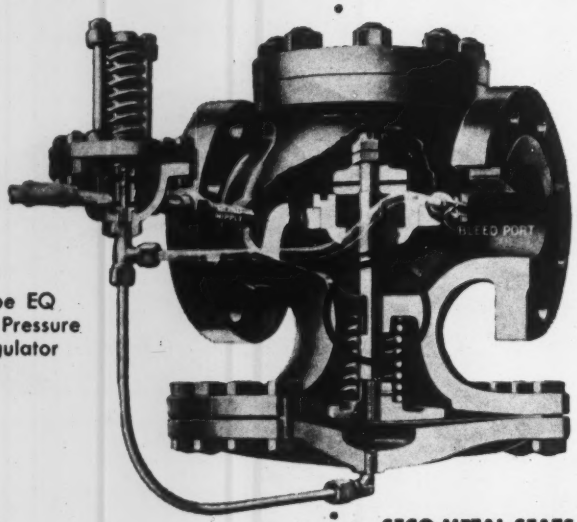
HOW SPENCE DESIGN...

eliminates stuffing boxes

All Spence main valves and most pilots are built without stuffing boxes. This packless construction is made possible by the use of a large balanced metal diaphragm which eliminates the need for closely fitted parts. Result? More accurate regulation.

Valve stem wear is also reduced in the Spence packless design. Result? Low maintenance, years of trouble-free service.

Spence makes a wide line of automatic regulating valves: Pressure, Temperature, Differential Pressure, Back Pressure, Pump Governors and many other types. Write for bulletin 100 giving full details.



Type EQ Back Pressure Regulator

A few other design features:

SECO METAL SEATS AND DISCS— Durable SECO Metal resists wiredrawing. More than twenty years of experience in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

PROTECTED SPRINGS— The internal springs in the Spence Main Valve and Pilot are out of the path of the steam or other fluid flowing through the valve. They operate at low unit stress for exceptionally long life.

METAL DIAPHRAGMS — Located in a cooled zone with a condensate seal above and below, never have to be replaced under normal conditions.

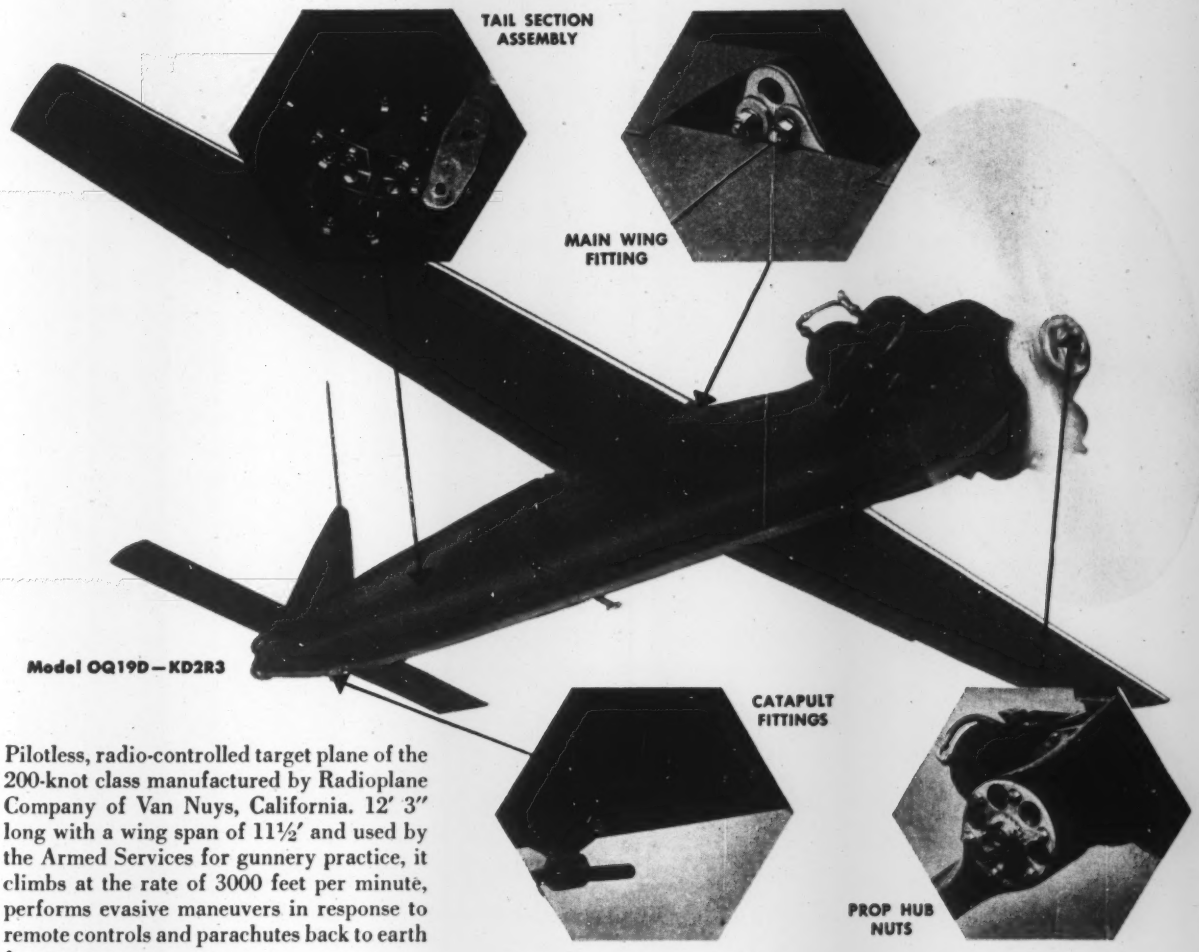
Spence

SPENCE ENGINEERING COMPANY, INC.

WALDEN, NEW YORK

SE 121

Target Plane Completely ESNA-Fastened



Pilotless, radio-controlled target plane of the 200-knot class manufactured by Radioplane Company of Van Nuys, California. 12′ 3″ long with a wing span of 11½′ and used by the Armed Services for gunnery practice, it climbs at the rate of 3000 feet per minute, performs evasive maneuvers in response to remote controls and parachutes back to earth for recovery.

Specified on every structural bolt, AN-approved Elastic Stop Nuts hold tight against stress and vibration . . . assure simplified field maintenance.

ELASTIC STOP NUT CORPORATION OF AMERICA
Dept. N20-211, 2330 Vauxhall Road, Union, New Jersey

Only ESNA manufactures a complete line of all types and sizes of Self-Locking Nuts.

BASTIAN-BLESSING
PRESSURE REGULATORS USE PARKER *Die Castings . . .*

and when you think of Die Castings THINK OF

Less than 3% *rejection on final* PRESSURE TESTS!

THE BASTIAN-BLESSING COMPANY manufactures the "RegO" line of liquefied petroleum gas equipment. To the LP-Gas industry "RegO" has become the symbol of quality—the assurance of a complete and satisfying service. The heart of the LP-Gas installation is the pressure reducing regulator—upon its accurate and reliable performance the entire system is dependant. Parker Die Castings were selected because they reduced machining costs to a minimum. On final tests, less than 3% of the castings were rejected—97% met the rigid requirements of tolerance and strength under high pressure. This is another instance when Parker Die Castings are serving industry. Parker Die Castings are economical. You can profit from Parker experience in designing and producing quality die castings for a variety of industrial and commercial applications. Consult with Parker on your next die casting requirements. The result will be mutually profitable.

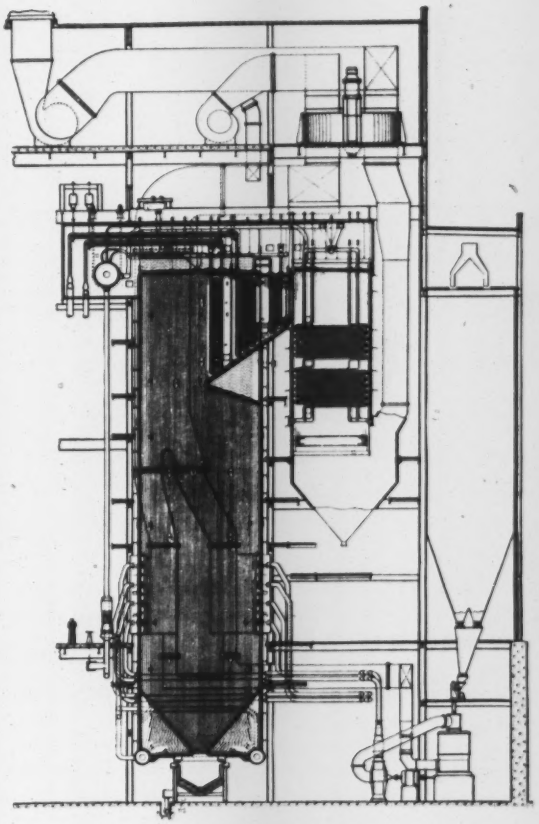
Parker White-Metal Company • 2153 McKinley Ave., Erie, Pa.

PARKER ALUMINUM *and* ZINC *Die Castings*

BUCK STEAM STATION

Duke Power Company

C-E controlled circulation boilers



The C-E Unit shown above is one of two duplicates now in process of fabrication for the Buck Steam Station, Spencer, N. C., of the Duke Power Company.

Each of these units is designed to serve a 125,000 kw turbine-generator operating at a throttle pressure of 1800 psi with a primary steam temperature of 1000 F, reheated to 1000 F.

These units are of the controlled-circulation, radiant type with a reheater section located between the primary and secondary superheater surfaces. An economizer section follows the rear superheater section and regenerative type air heaters follow the economizer surface.

Pulverized coal firing is employed, using bowl mills and tilting, tangential burners.

B-594

C-E

COMBUSTION ENGINEERING—SUPERHEATER, INC.

200 Madison Avenue, New York 16, N. Y.

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS

No room for guesswork HERE

complete modern laboratories make sure that FLEXON BELLOWS will meet your requirements

The mass spectrometer pictured above is only one of the modern devices used by Flexonics Corporation to verify the high quality of FLEXON Bellows and give assurance that they will meet your specifications. This laboratory background coupled with bellows manufacturing skill provides a complete service to all manufacturers who use bellows in their products.

FLEXON Bellows are made in brass, bronze and stainless steel in a complete range of sizes. When required, bellows assemblies can also be furnished.

For complete information and recommendations, send an outline of your needs.

The FLEXON Bellows Design Guide gives full information on FLEXON Bellows as well as useful data on selection of bellows. Write for a copy.

Flexonics *Corporation*

FLEXON BELLOWS DIVISION
1305 S. THIRD AVENUE · MAYWOOD, ILLINOIS

FORMERLY CHICAGO METAL HOSE CORPORATION

Flexon identifies products of Flexonics Corporation that have served industry for over 50 years.

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals · Expansion Joints for Piping Systems · Stainless Steel and Brass Bellows · Flexible Metal Conduit and Armor · Assemblies of These Components

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

STAINLESS STEEL BELLOWS ASSEMBLIES

...Designed for YOU to SAVE for you!

● Whatever your requirements for stainless steel bellows assemblies may be, you can be assured of getting *exactly* what you need from Fulton Sylphon or Bridgeport Thermostat.

We design and engineer assemblies to do specific jobs. For example—for use where there's a design problem involving control of temperature or pressure . . . opening and closing of valves, dampers, etc. . . . absorbing expansion . . . providing packless construction . . . for more uses throughout industry.

And add *these* advantages that help make savings for you: Half-a-century of experience in this specialized field . . . skilled personnel . . . complete production facilities . . . ability to produce in any volume. All combine to relieve you of production problems and worries, help save you time and money.

Consult us on your present bellows assemblies requirements—or on any project where an assembly must be designed for your specific needs. Stainless steel or other metals—wide size range. For information, write for idea-filled Catalog CK-1200.

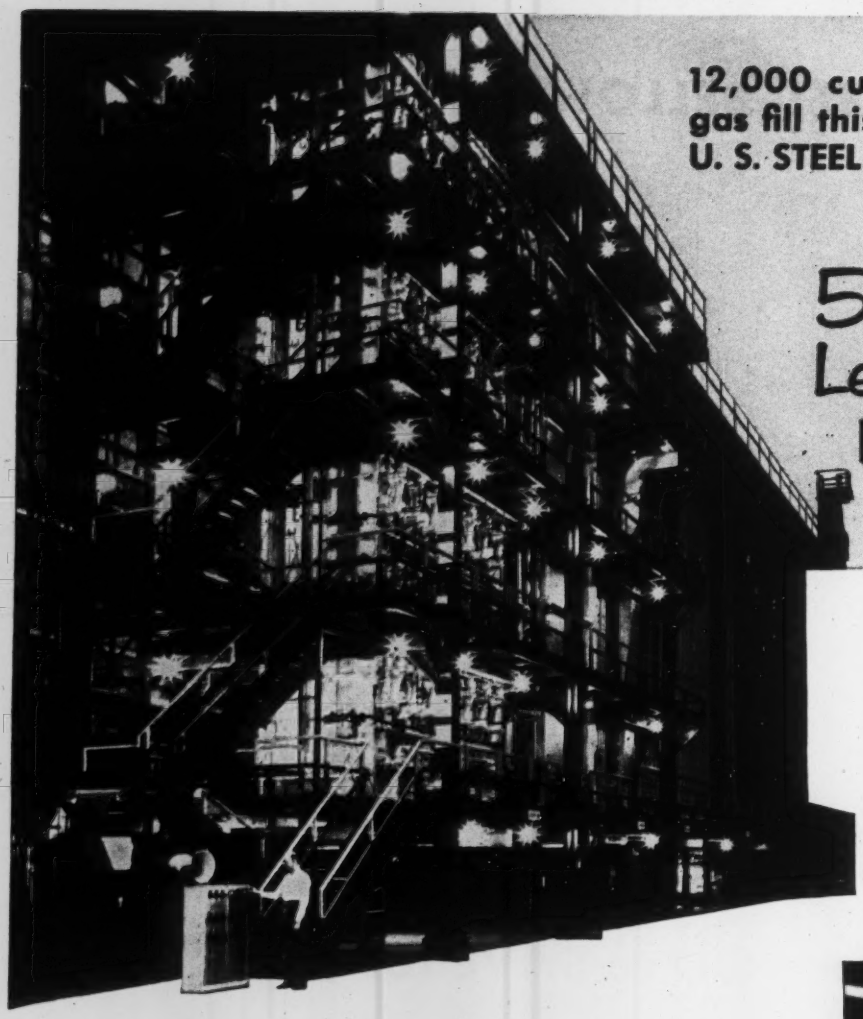
TEMPERATURE CONTROLS

FULTON SYLPHON
DIVISION
Knoxville 4, Tenn.

Robertshaw-Fulton
CONTROLS COMPANY

BELLOWS ASSEMBLIES • BELLOWS DEVICES

BRIDGEPORT THERMOSTAT
DIVISION
Bridgeport 1, Conn.



12,000 cubic feet of inert gas fill this furnace to help U. S. STEEL produce cleaner, brighter tin plate

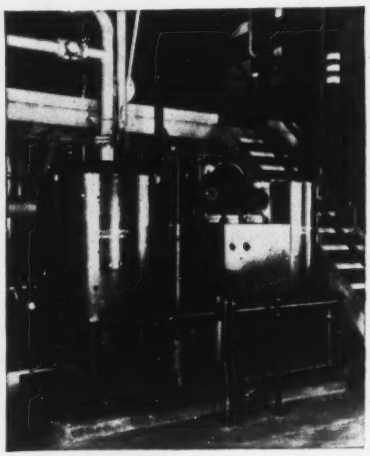
5 Lectrodryers* DRY that gas

Strip is only in this furnace about 105 seconds: 20 seconds in the heating zone, 15 seconds in the holding zone, 15 seconds for slow cooling and then into the rapid cooling zone.

30 tons of tin plate per hour! That's the production pushed through this tower-type annealing furnace at U. S. Steel's Sheet and Tin Mill in Gary. And the strip comes out uniformly annealed, flat, clean and bright.

The DRY protective atmosphere that fills the furnace assures that brightness. Two blowers recirculate this gas, creating considerable turbulence to accelerate heat transfer. Five Lectrodryers keep the gas DRY.

To men having trouble with unwanted moisture in air, gases or organic liquids, Lectrodryer engineers offer their services. Write Pittsburgh Lectrodryer Corporation, 335 32nd Street, Pittsburgh 30, Pennsylvania.



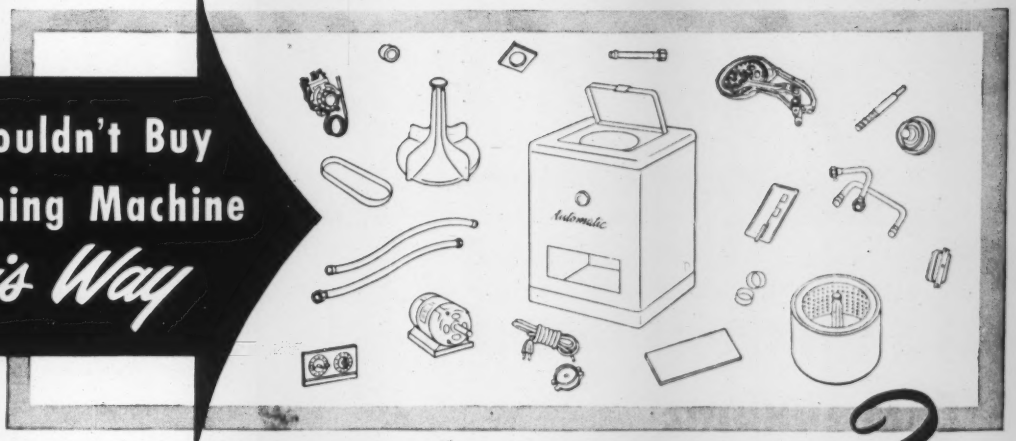
Furnace built by General Electric Company, with the co-operation of Surface Combustion Corporation.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

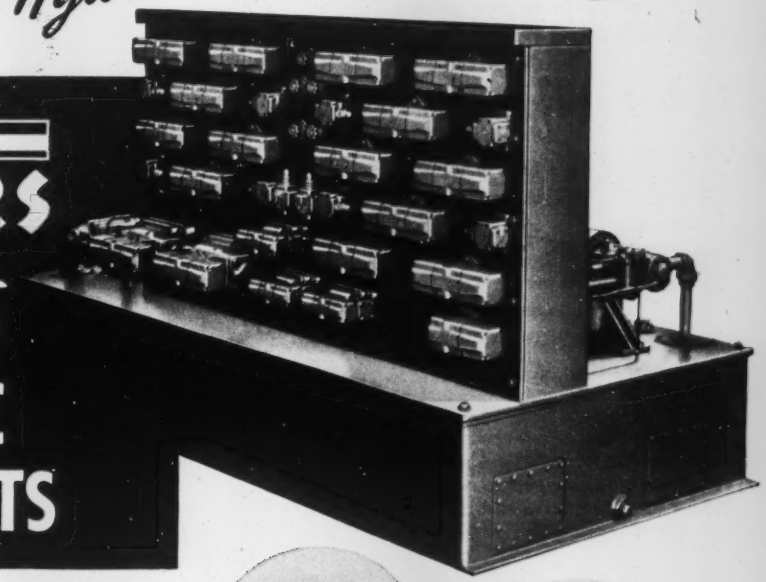
LECTRODRYER

* REGISTERED TRADEMARK U. S. PAT. OFF.

You Wouldn't Buy a Washing Machine *This Way*



Then Why Buy Hydraulics Piecemeal?



VICKERS *Custom-Built* HYDRAULIC POWER UNITS

You would never go to the trouble of buying automatic washing machine parts and assembling them yourself. It would take a lot of time and patience and trouble. For one thing the maker could not risk guaranteeing the finished job. You buy a washing machine as a unit, and want the undivided responsibility of the manufacturer.

Then why buy hydraulics piecemeal when there are so many advantages in a Vickers Custom Built Power Unit? It is built to meet your individual requirements, in a compact, neat, self-contained "package." It includes all necessary pumps, valves, intermediate piping, oil reservoir, motors, controls etc. as well as all hydraulic accessories (oil filters, air cleaners, oil level gauges, fittings etc.). Hydraulic connections are grouped in a convenient manifold.

Hydraulic design is simplified and improved, and you save substantially on installation and maintenance cost. Vickers takes undivided responsibility for the entire hydraulic system and you get the benefit of Vickers skill and experience. These advantages are important to both the machine builder and his customer.

Ask the nearest Vickers factory-trained application engineer to send you new Bulletin 52-45 or to make a personal call.

Improve and Simplify Hydraulic Design

Reduce Installation and Maintenance Costs

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1500 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices:

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ROCHESTER • ROCKFORD • SEATTLE • TULSA
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6071

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

First with Super-

ALLIS-CHALMERS INSTALLS STEAM TURBINE GENERATOR UNIT WITH SUPERCHARGED HYDROGEN COOLING

SUPERCHARGED HYDROGEN COOLING—the greatest advance yet made in turbine-generator design—is here *now*. This 60,000 kw unit is installed and running at the Edgewater station, Sheboygan, of the Wisconsin Power & Light Company.

Allis-Chalmers is first to develop and apply the principle of directly cooling the conductors with high velocity gas. This unit is the pioneer of a new design trend. Following operating experience, the utility ordered two more similar units, with reheat, for its new Rock River station.

As compared to the 35 percent output gain hydrogen cooling gives over air cooling, supercharged hydrogen cooling increases generator ratings *70 percent* over ordinary hydrogen cooling. Significant gains are made in increasing light load efficiencies and decreasing foundation and building requirements!

The Edgewater turbine has these outstanding features:

Hydraulic control and operation with accessible placement of main stop valve; centralized grouping of operating controls; shaft-driven centrifugal pump simplifying location of oil tank; cam-operated inlet valves accessibly located on top of cylinder, and exclusive A-C method of temperature compensation for horizontal *and* vertical thermal movement.

All oil piping is above the floor, simplifying foundation and installation. And, as throughout the complete Allis-Chalmers line — ranging from the smallest single cylinder machines to single shaft, tandem compound, condensing units of 150,000 kw — labyrinth steam seals are used. The steam sealed gland system is self-contained, and provides operational safety with minimum attention.

You get the real design advances *first* from Allis-Chalmers. When planning the installation or expansion of a steam-electric power plant, let A-C simplify your problem. This *one* source will provide you with the world's widest range of power plant equipment. Bulletin 03B6801A on standardized steam turbine units and other literature on all products listed are available. For your copies, call your nearest A-C office or write to Allis-Chalmers, Milwaukee 1, Wis.

A-3645

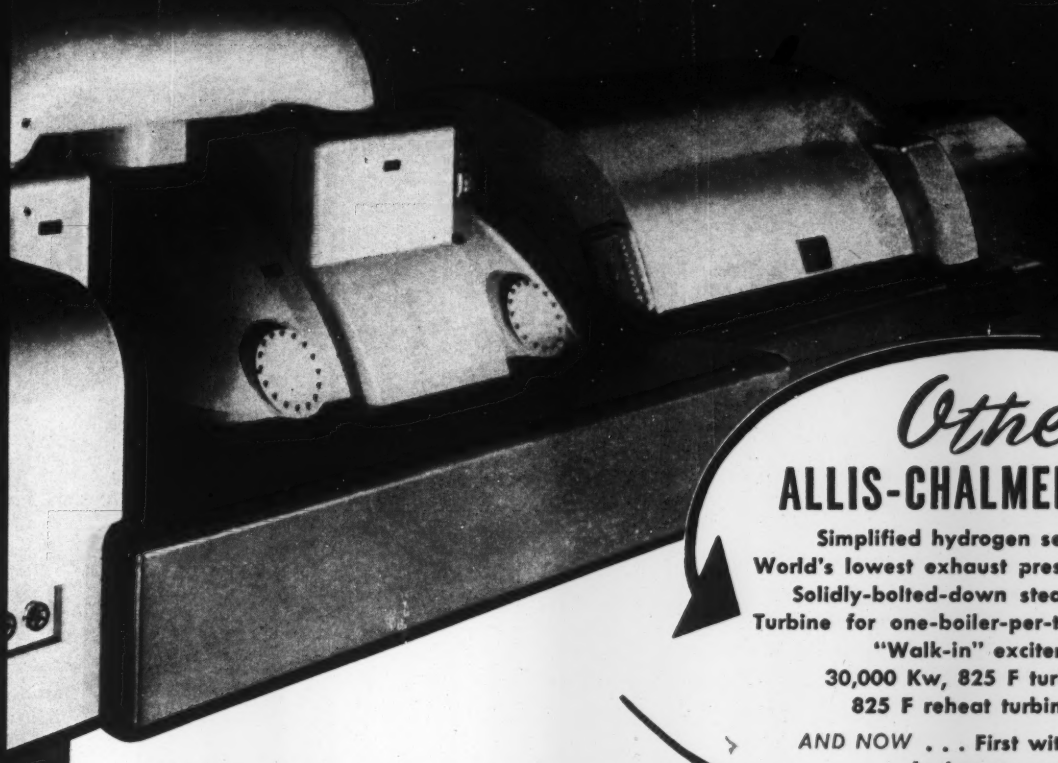
ALLIS-CHALMERS

A-C ALLIS CHALMERS

World's Widest Range of Power Plant Equipment

TURBINES & GENERATORS | CONDENSERS & PUMPS | SWITCHGEAR & BREAKERS | MOTORS & CONTROL | TRANS-FORMERS | WATER CONDITIONING

Charged Cooling!

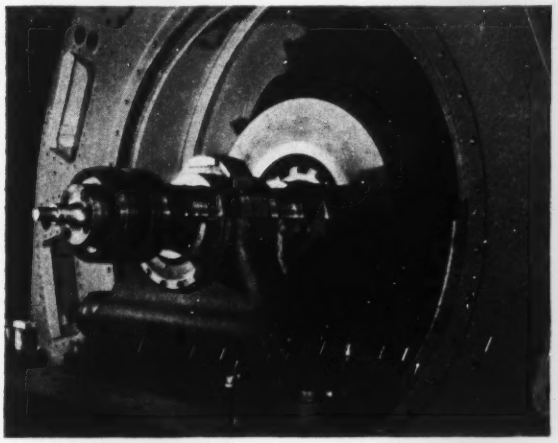


Other ALLIS-CHALMERS FIRSTS

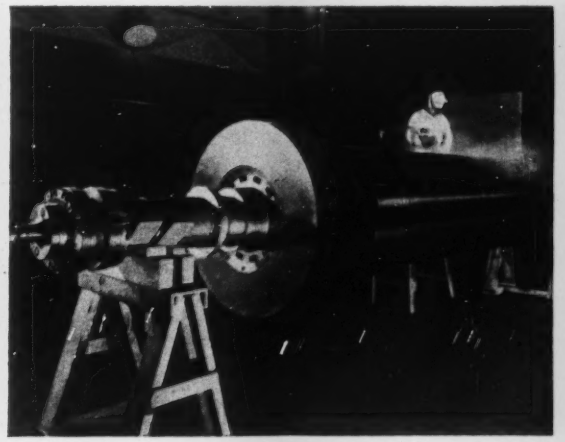
Simplified hydrogen seal and control
World's lowest exhaust pressure steam turbines
Solidly-bolted-down steam end pedestal
Turbine for one-boiler-per-turbine arrangement
"Walk-in" exciter housing
30,000 Kw, 825 F turbine, in 1931
825 F reheat turbine, in 1935

AND NOW . . . **First with supercharged hydrogen cooling!**

This 60,000 kw, 3600 rpm AIEE-ASME preferred standard unit is driven by an Allis-Chalmers tandem compound steam turbine. Steam conditions are 1250 psig, 930 F, 1½ in. Hg abs exhaust. The Edgewater station consists of this and two Allis-Chalmers 30,000 kw units.



Twenty years of Allis-Chalmers blower experience aided in the design of the new rotor ventilating system. The two stage centrifugal compressor at the exciter end of the rotor "supercharges" the hydrogen to several times the pressure obtained from the usual cooling fans. Its output is cooled separately and directed into the rotor from both ends.



Shop view of rotor during construction. Instead of being sent to vent ducts in the rotor teeth, the hydrogen is directed *through* the rotor conductors. The gas is in intimate contact with the copper right where the heat originates. This improved ventilation permits a reduction in unit length and consequent reduced building space requirements.

REPUBLIC
INSTRUMENTS
AND CONTROLS

Do You Know About ALL of the **REPUBLIC** *Line?*

Check the Republic line of measurement and control equipment listed below. You'll find instruments and controls to meet your needs—whether for a simple control or an automatic control system. And teamed with this equipment is an experienced engineering staff which can give you the right answer to your measurement and control problems.

☐ **ELECTRICAL FLOW METERS.** For metering the flow of steam, water, gas, air, oil, brine, etc. The reading instruments, indicator, recorder and integrator, are remote reading and can be supplied singly or in any combination desired. Integration is continuous, an exclusive Republic feature.

☐ **PNEUMATIC TRANSMITTERS.** For converting process variables such as flow, liquid level, pressure, or liquid density into air pressures which vary proportionally with the process variables. These air pressures can be used as a measuring impulse for the actuation of an automatic controller or a direct reading recorder.

☐ **CO_2 METERS.** Provide a continuous record of percent CO_2 in flue gas measured by the Orsat method. Furnished with either mechanical or electrically actuated remote reading indicator and recorder.

☐ **DRAFT INSTRUMENTS.** Indicating or recording types in single or multiple units. Furnished in all standard ranges of draft and pressure.

☐ **THERMOMETERS.** A long distance, gas filled thermometer with either single or multiple pen recorder.

☐ **LIQUID LEVEL INSTRUMENTS.** Remote reading indicators and recorders. Also provided with various types of alarm devices.

☐ **MULTI-POINT INDICATORS.** Will indicate, on separate vertical scales from two to sixteen units of draft, pressure, flow, temperature, CO_2, etc., in any combination desired.

☐ **MULTIPLE RECORDERS.** Strip Chart Type will record from three to six separate records of flow, temperature, CO_2, pressure, etc., in any combination desired. Round Chart Type can have up to 4 pens.

☐ **REGULATORS.** For the automatic control of pressure, draft, rate of flow, rate of fuel feed, speed of rotation, liquid level, etc. For proportioning two pressures or flows. Regulators may be either air or oil operated. Flexibility in design and construction allows the regulator to perform any type of control action. Setting may be remote or manual.

☐ **AUXILIARY RELAYS.** Multiplying, dividing, adding, subtracting, maximum and minimum setting, ratio, ratio computing, sequential, splitter, squaring, square root extracting, and position indicating.

☐ **COMBUSTION CONTROLS.** A centralized, automatic system for controlling steam pressure, combustion, furnace pressure, excess pressure, boiler level, etc. Automatically regulates the fuel and air input to a boiler in measured proportions and in a fixed ratio for the entire load range. Adaptable to multi-fuel firing.

☐ **DESUPERHEATERS.** Atomizing type desuperheater uses a small quantity of high pressure steam to vaporize an automatically controlled amount of water in reducing steam temperature to the desired degree.

☐ **VALVES—REGULATING AND PRESSURE REDUCING.** Designed and built for all practicable ranges of pressures with either flanged or welded ends. Special body design sharply reduces erosion and noise. Cylinder operated valves available in sizes from 3 in. to 24 in. Hand operated valves in sizes from 1 in. to 8 in. Lever operated valves in sizes up to 16 in. Republic valves are built in accordance with A.S.A. Standards for all pressures up to 2500 psi. Diaphragm operated valves are available for pressures from 125 to 1500 psi and from 3 in. to 10 in. in size. Special purpose alloy steel butterfly valves in sizes 4 in. to 24 in. are also available.

Data Books are available on any of the above equipment

REPUBLIC FLOW METERS CO.

2240 Diversey Parkway • Chicago 47, Illinois

BRANCH OFFICES: Atlanta • Albuquerque • Boston • Buffalo • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston Indianapolis • Kansas City, Mo. • Los Angeles • Minneapolis • New Orleans • New York City • Philadelphia . Phoenix • Pittsburgh Richmond • St. Louis • Salt Lake City • San Francisco • Seattle • Syracuse • Shreveport • Tulsa • Vancouver, B. C.

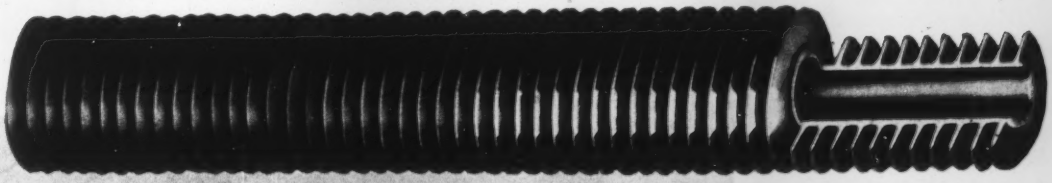
LOOK!

THE FINS OF WOLVERINE TRUFIN* HAVE BEEN SQUEEZED

right out of the tube wall

They are the tube itself—the fins and the tube are integral.

Thus they can withstand vibration and sudden temperature changes—assuring full efficiency at all times.



Trufin is available in (1) a variety of alloys, (2) in fin spacings 5, 7, 9, 11, 16 and 19 fins to an inch and (3) in a range of inside diameters from 5/16" to 1".

Also available in bi-metal with an integral fin construction and different metal lining.

Ask for our new Catalog 201 that will give you more detailed information. If you have an immediate problem dealing with heat exchangers we invite you to call our Customer Engineering Service which can offer much helpful information.

*REG. U. S. PAT. OFF.

WOLVERINE TUBE DIVISION

of Calumet & Hecla, Inc.

Manufacturers of tubing exclusively

1437 Central Ave. Detroit 9, Mich.

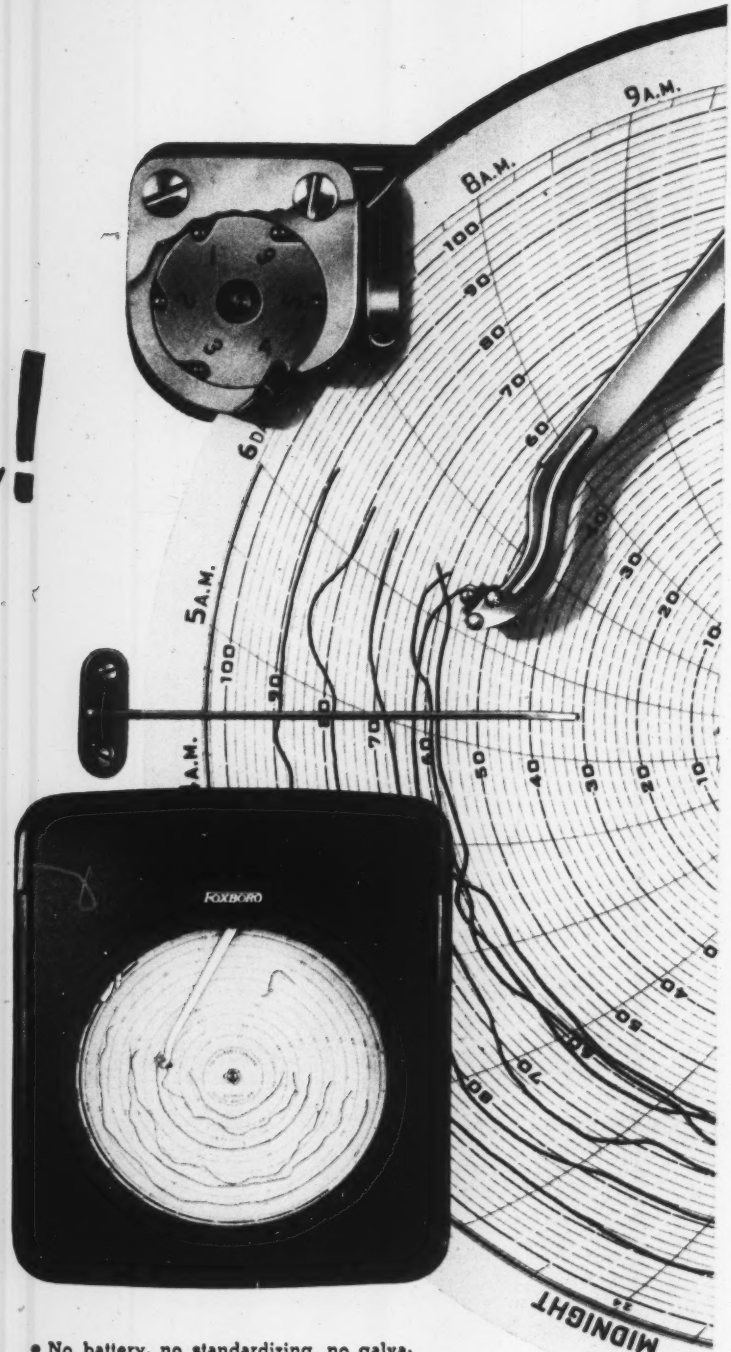
Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

What a record!

...6 Color-coded Temperature Records on one ROUND Chart



THE MULTI-RECORD DYNALOG*

What convenience! What economy! You can record up to 6 related temperatures on a single *circular* chart with this Foxboro Multi-Record Dynalog. Not only saves panel space, but simplifies comparison of records. There's only one pen arm—yet all 6 records appear in different, distinctive colors. Bulletin 427-1 tells the complete story. Write for your copy. **The Foxboro Company, 962 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U. S. Pat. Off

Check these outstanding features

- **High speed recording — only 6 seconds between prints for quick detection of process variations.**
- **Uses convenient, low cost circular charts.**
- **Each record line has its own distinctive, non-smudging color.**
- **No battery, no standardizing, no galvanometer, no slide wire.**
- **Unmatched accuracy, lowest maintenance, greatest convenience.**
- **Available with alarms or on-off control.**
- **Thermocouple or resistance-bulb types.**

FOXBORO REG. U. S. PAT. OFF. — MULTI-RECORD DYNALOG

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

BIGELOW-LIPTAK

Coal Dryer Furnaces

FEATURE

THIN WALLS ...in the heat of things

Special air inlet tile—developed from B-L's modern, unit-suspended thin wall—cuts maintenance to the bone in this coal dryer furnace.

The furnace furnishes 93,000,000 BTU's at a temperature of 1200° F to a rotary dryer. This application of thin wall construction features a specially-designed air inlet tile.

Ample furnace volume is provided to permit efficient stoker operation. The air-inlet tile permits tempering air to be drawn into the enclosure to reduce the flame and furnace temperature. Adjustable louvres located in the upper front and side walls draw outside air over the arch and down into the wall air lanes and into the furnace. When a constant volume of gases at a certain temperature is desired, it is only necessary to adjust the louvres. Radiation losses are reduced to a minimum by recovering and re-introducing the pre-heated air into the furnace.

Bigelow-Liptak dryer furnaces furnish heat for the coal, chemical, lumber, salt, sugar, grain and other industries.

Write for this catalog—today!

BIGELOW-LIPTAK *Corporation*

and Bigelow-Liptak Export Corporation

2550 W. GRAND BLVD. • DETROIT 8, MICHIGAN

UNIT-SUSPENDED WALLS AND ARCHES

In Canada: Bigelow-Liptak of Canada, Ltd., *Toronto, Ontario*

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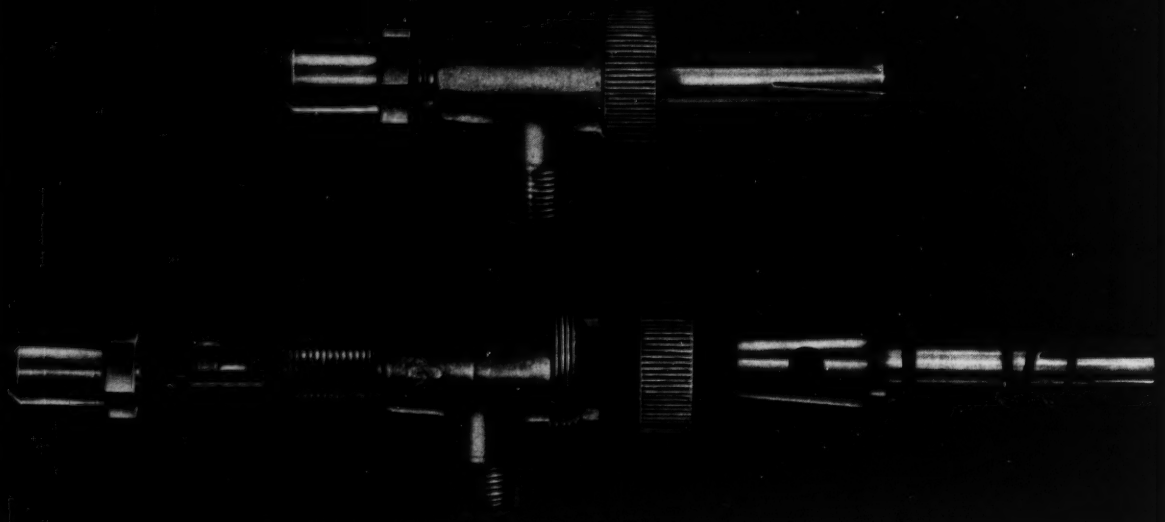
LINCOLN FINDS

Brass is Best



Kitchen range burner valve by Lincoln Brass Works, Inc., Detroit 16, Mich. Two different brasses are used in this valve, which is entirely of brass except for the washer and spring. Lincoln also makes valves for heaters and furnaces; flow, drain and shut-off valves for gasoline lines; shut-off valves for agricultural sprayers, and a wide variety of tube and pipe fittings, all entirely or chiefly of free-cutting brass rod and free-machining brass forgings.

Mr. D. E. DuPerow, Vice-President of Lincoln Brass Works, Inc., recently said: "Thirty-six years of brass use by Lincoln and complete acceptance by the trade is the best reason I can think of for brass superiority. If there had been any material better for our purpose, less expensive to fabricate, and more desirable to our customers, we would be using it now."

Brass has many desirable characteristics. Here are five of them that are important in Lincoln valves and fittings: 1, corrosion resistance, which means no plating is required. 2, high speed precision machining for high output, lower costs. 3, sound, non-porous structure of rod and forgings. 4, smooth performance; brass holds lubricants. 5, customer satisfaction; gas range burner valves pass the cycling test of being raised to 425°F. and back to room temperature a minimum of 10,000 times without seizure, loss of free operation, or leakage.

There are many other items besides valves that can profitably make use of the fine qualities of Revere Brass. The Revere Technical Advisory Service will gladly cooperate with manufacturers on the selection of the correct brass and its fabrication. Just call the nearest Revere Sales Office; see your telephone directory. Or write direct.

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COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

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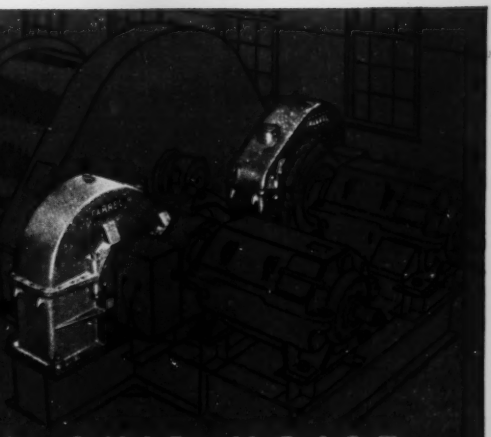
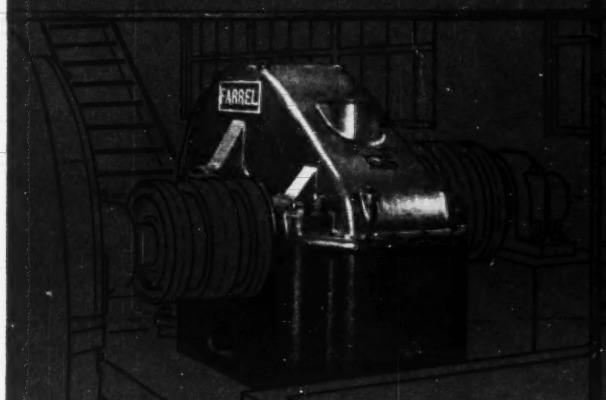
SEE REVERE'S "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

WHAT THE Design Flexibility OF FARREL® SPEED REDUCERS MEANS TO...

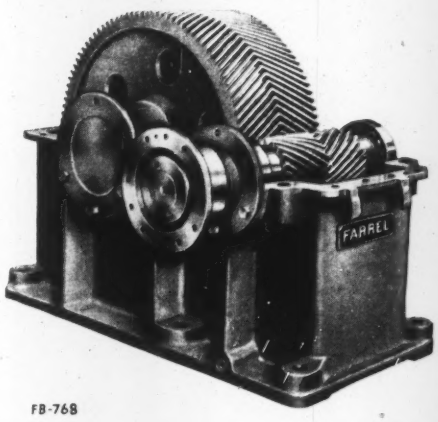


...A SKIP HOIST



...A ROLLING MILL

...A ROTARY KILN



FB-768

Design flexibility means the same thing in each of these applications: *a speed reducer that meets the drive requirements exactly.*

Farrel speed reducers, unlike most "standardized" products, are standard only in their principal features. They are adaptable in critical detail. Gears, shafts, bearings, and even some housing dimensions, can be proportioned to meet specific load, speed and service requirements. This flexibility has resulted in the solution of innumerable application problems.

In addition to this feature, Farrel speed reducers have a number of other advantages. The quiet, vibration-free performance of the herringbone gears results from extreme accuracy of tooth spacing, contour and helix angle . . . qualities inherent in the Farrel-Sykes method of gear generation. Precision manufacture and highest grade materials contribute to long gear life.

Shafts and bearings are factored to safeguard against interruption of vital processes. Gear cases are proportioned to withstand repeated heavy peak loads. Joints are sealed to prevent entrance of dirt.

Write for further details of these problem-solving units. Ask for a copy of Bulletin 449.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONNECTICUT

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Detroit, Chicago, Memphis, Minneapolis, Portland (Oregon), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

Farrel-Birmingham®

You can't stop a rhino with a popgun

You can't stop corrosion with ordinary paints ...it takes BITUMASTIC COATINGS!

CORROSION can't be stopped by ordinary paints or conventional protective coatings. They can't protect surfaces against the ravages of rust for any appreciable length of time. But Bitumastic Coatings can. Here are three principal reasons:

1. Unlike maintenance paints, Bitumastic® Protective Coatings are specially formulated from a coal-tar pitch base* that is, for all practical purposes, impervious to water. When you keep moisture away from an exposed surface, you *stop* corrosion.

2. Bitumastic Coatings provide an extra-tough, extra-thick barrier against corrosive elements—a barrier that is impenetrable. These coatings provide up to 8 times the film thickness of conventional paint coatings.

3. Bitumastic Coatings stop corrosion caused by moisture—acid fumes—alkaline fumes—corrosive soil—salt air—heat.

**Hi-Heat Gray contains a metallic base.*

There are 6 Koppers Coatings—formulated to control corrosion of metal and deterioration of concrete. Use the coupon for full information, or see our catalog in Sweet's Plant Engineering File.

SEND FOR SET OF FREE BOOKLETS!

Koppers Company, Inc., Tar Products Division
Dept. 269-T, Pittsburgh 19, Pa.

Please send me, without charge or obligation, complete information on corrosion prevention.

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Address .....
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KOPPERS BITUMASTIC PROTECTIVE COATINGS

SOLD THROUGH INDUSTRIAL DISTRIBUTORS

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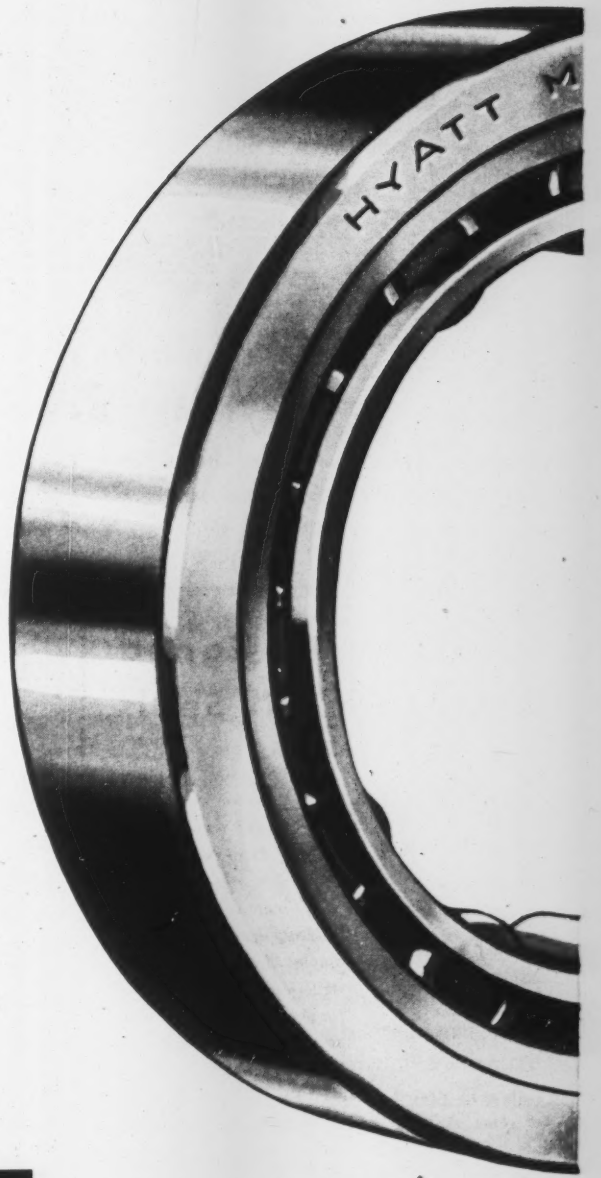
DISTRICT OFFICES: BOSTON, CHICAGO, LOS ANGELES, NEW YORK, PITTSBURGH, AND WOODWARD, ALA.

10 designs for heavy duty



Ten different Hyatt Hy-Load designs, each in a variety of widths and sizes, assure you the right bearing for every radial need.
Four Hy-Load designs have separable inner races, two have separable outer races and four are non-separable. All are high-capacity, cylindrical roller bearings for the heaviest radial loads and light or intermittent thrust loads.
All separable parts are freely interchangeable within the same size. This permits non-selective fitting after pre-assembling the two bearing parts in separable machine elements.
Whatever your radial load problem, Hyatt Hy-Loads or some of the other types of Hyatt bearings can provide the answer. Because Hyatt offers industry's most complete line of straight radial roller bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

DOUBLE PROTECTION FOR BEARINGS

1. Keeps oil and grease in

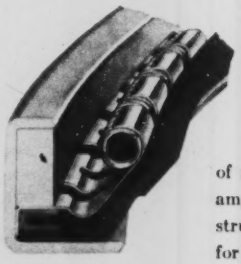
2. Keeps dust, dirt and water out

Bearings *last longer* and require *less maintenance* when they're protected by Garlock KLOZURE Oil Seals. These superior oil and grease seals keep the lubricant sealed *in*—keep dirt and contaminating materials locked *out*.

Garlock KLOZURES are produced in a wide range of sizes including Metric to fit standard International Millimeter ball and roller bearing housings. *For complete information write for Klozure Catalog No. 10.*

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK
In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

Specially Designed KLOZURE Oil Seals

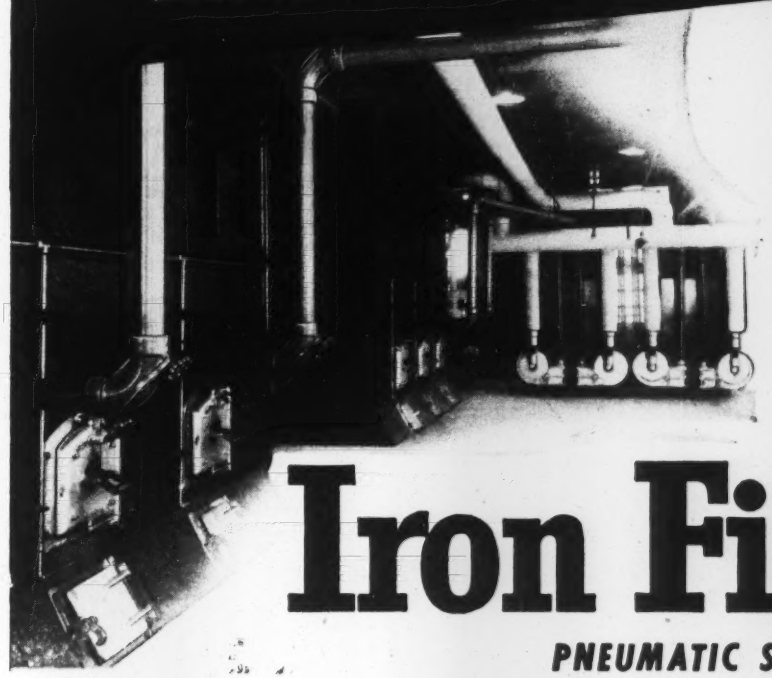


For those applications for which none of our regular KLOZURE models are suitable we design and manufacture oil seals of many special types. Examples of such special constructions are . . . small seals for needle bearings . . . seals for self-aligning or spherical bearings . . . and heavy duty seals as illustrated at the left for steel mill roll necks or other shafts of large diameter. If you have a bearing seal problem let our experienced technical staff solve it for you.

GARLOCK
Klozure*
Oil Seals
For all types of bearings

*Registered Trademark

Burns either Coal or Wood Waste



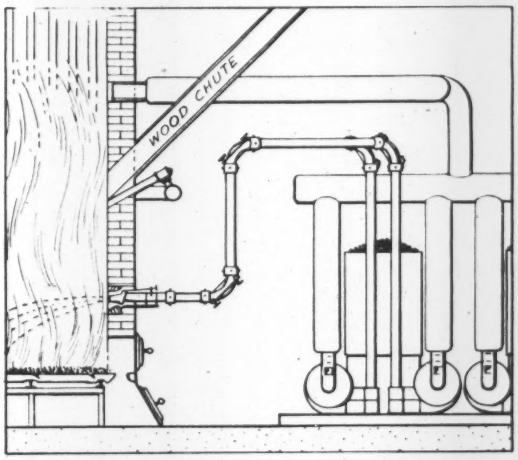
Iron Fireman coal stokers enable Bassett Furniture Industries to utilize wood refuse as fuel

These Iron Fireman Pneumatic Spreader stokers pick up the load automatically the moment the supply of wood refuse runs out. They enable the company to use wood waste as a primary fuel. Only enough stoker coal is burned to maintain a uniform steam supply.

Iron Fireman automatic air control and exclusive air-cooled grates give top firing efficiency with both fuels. Stokers are installed in six boilers, each with a capacity of 40,000 lbs. of steam per hour, which carry the power load for the various Bassett factories.

Iron Fireman

PNEUMATIC SPREADER COAL STOKERS



Coal is thoroughly dried and preheated before it is conveyed pneumatically to furnace grates. The distributor nozzle spreads the dry coal over the *entire* grate in a shallow, uniform fuel bed. Preheated fines burn in suspension, reducing cinder carryover and greatly improving combustion efficiency and responsiveness as compared with stokers which do not preheat coal. Wood waste is fed through chute at upper right.

You save three ways when you install an Iron Fireman Pneumatic Spreader stoker. You save on installation costs, you save on labor costs, and you save on fuel costs. This outstanding coal firing system dries, preheats, conveys and fires the coal. Manual coal handling is completely eliminated. Coal is piped directly from bunker to fire, doing away with the costly coal handling equipment usually required.

The Iron Fireman Pneumatic Spreader stoker burns a wide range of coals, including low ash fusion, sub-bituminous and lignite—ranging from one fourth inch slack to two inch top size. Readily adaptable to any boiler room layout. Capacities available to 1,000 boiler horsepower in single units; multiple units for larger capacities.

Dual and Triple Fuel Firing

While Iron Fireman stokers are often used in conjunction with the firing of wood waste, they are also readily combined with Iron Fireman oil and gas burners. The ability to shift fuels quickly will protect your plant against fuel shortages and permit advantageous buying of fuel. Send for descriptive literature.

Coal, Gas, Oil firing equipment for heating, processing, power

THE IRON FIREMAN

IRON FIREMAN MANUFACTURING COMPANY
2059 West 106th Street, Cleveland 11, Ohio.
Send me literature on the Iron Fireman Spreader Stoker.

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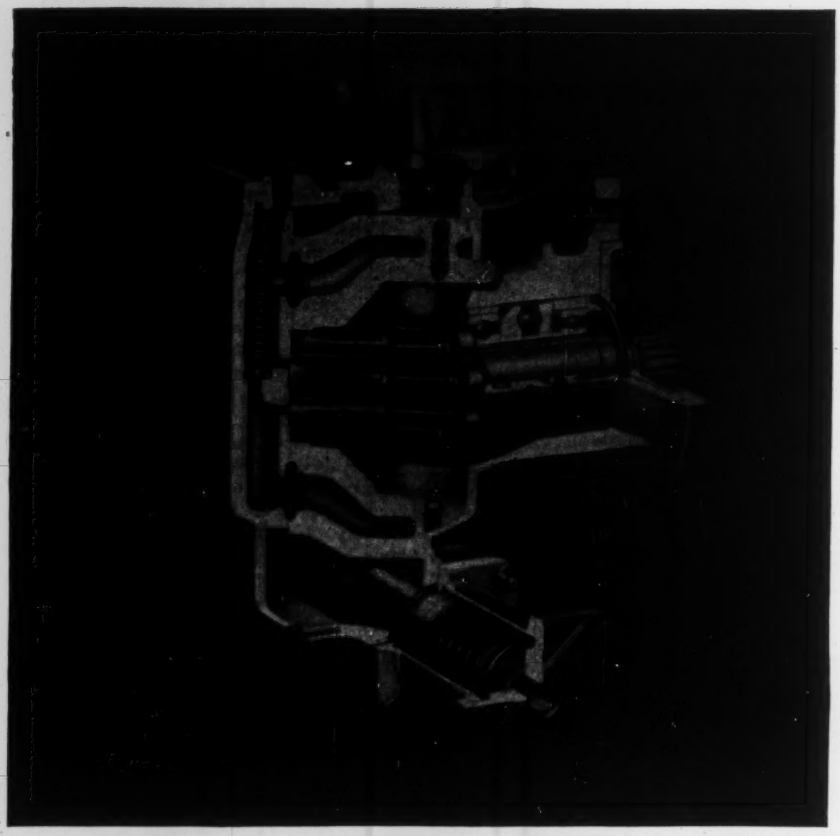
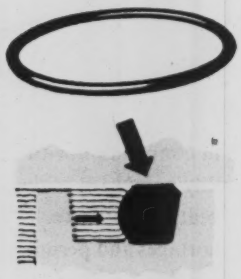


Cutaway view showing O-rings. Illustration courtesy Vickers, Inc.

PARKER O-RINGS help pumps set endurance record

THIS IS IT



Cross section drawing of O-ring in groove, sealing under pressure.

Vickers reversible flow 3,000 PSI hydraulic pumps, equipped with PARKER O-rings, recently operated 304,578 pump hours without malfunction for a 12-month period at one airline.

This noteworthy performance—in all sorts of weather—demonstrates the leakproof, long service qualities of PARKER O-rings . . . precision-molded from superior synthetic rubber compounds. Important, too, they provide simplified as well as efficient sealing. Design involves only a small groove to retain the ring. They are economical to use, easy to replace.

PARKER is the one source for *all* standard O-rings for fuel, hydraulic and engine oil services, and for special service O-rings. Ask your PARKER Distributor for Catalog 5100, or write The PARKER Appliance Company, 17325 Euclid Avenue, Cleveland 12, Ohio.

Parker

TUBE FITTINGS • VALVES • O-RINGS

Plants in Cleveland • Los Angeles • Eaton, Ohio • Berea, Ky.

Parker O-RINGS

ARE STOCKED BY THESE AUTHORIZED DISTRIBUTORS

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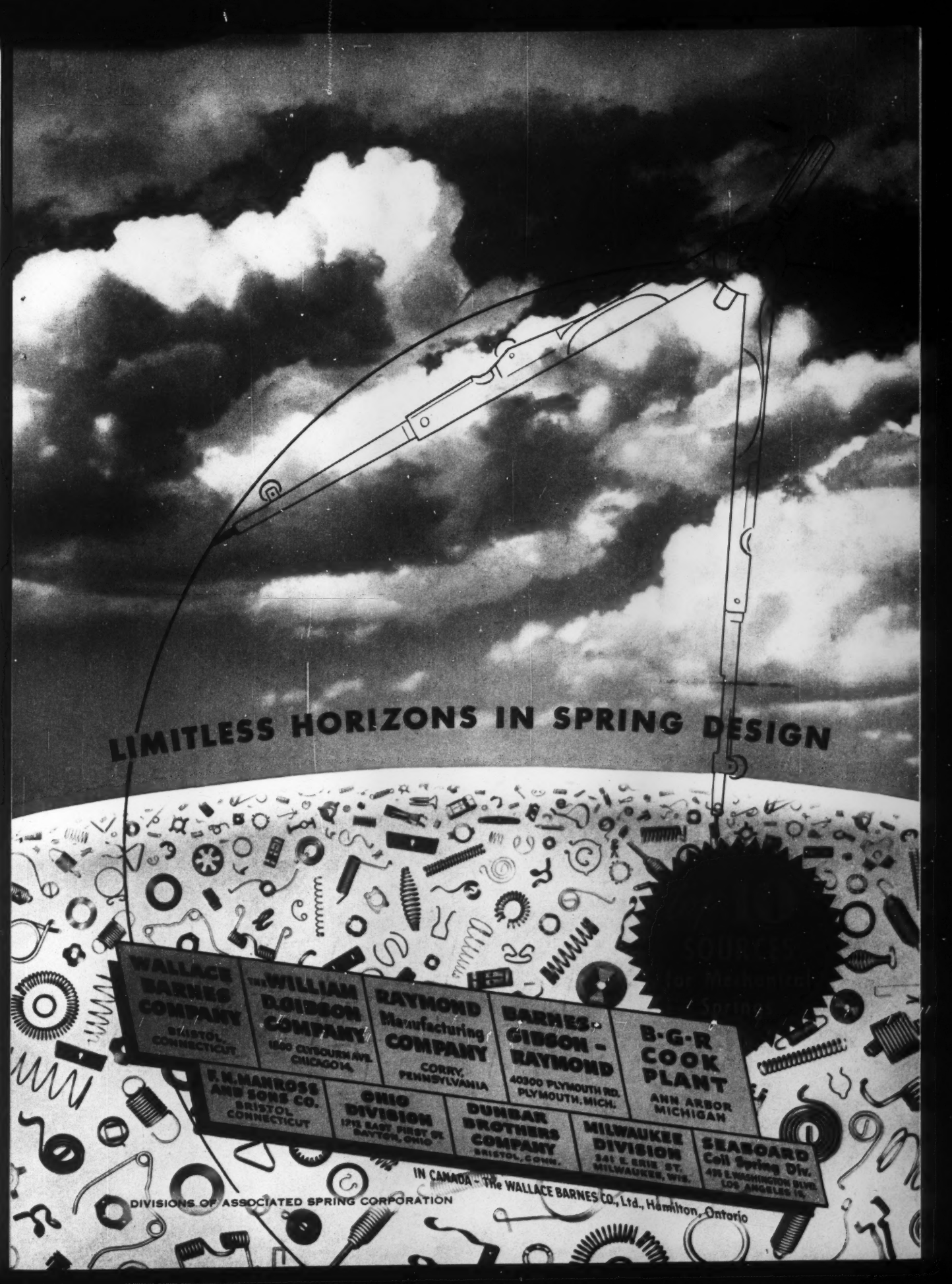
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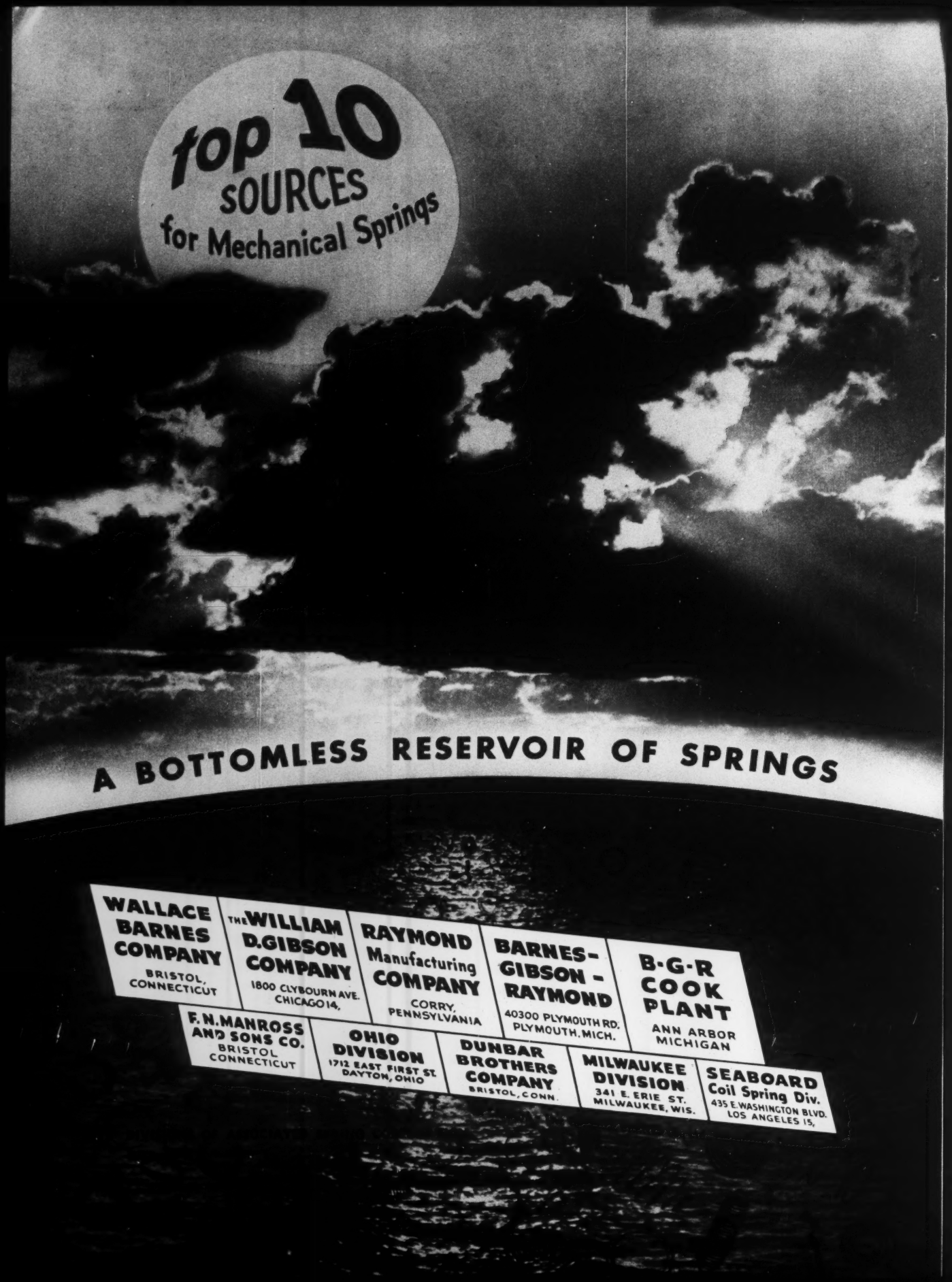
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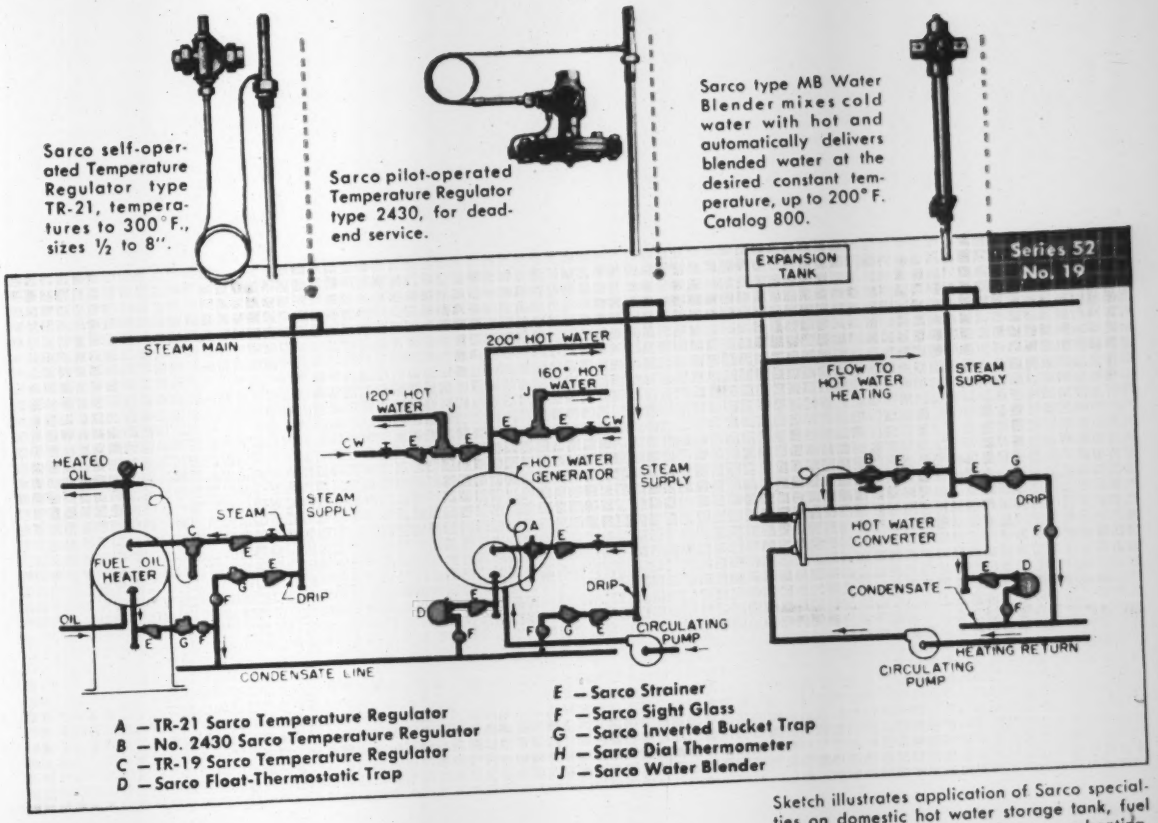

Sarco self-operated Temperature Regulator type TR-21, temperatures to 300°F., sizes ½ to 8".
Sarco pilot-operated Temperature Regulator type 2430, for dead-end service.
Sarco type MB Water Blender mixes cold water with hot and automatically delivers blended water at the desired constant temperature, up to 200°F. Catalog 800.
Series 52 No. 19
EXPANSION TANK
STEAM MAIN
200° HOT WATER
160° HOT WATER
120° HOT WATER
HOT WATER GENERATOR
STEAM SUPPLY
FLOW TO HOT WATER HEATING
HEATED OIL
STEAM
FUEL OIL HEATER
OIL
DRIP
CONDENSATE LINE
CIRCULATING PUMP
HOT WATER CONVERTER
CONDENSATE
HEATING RETURN
A — TR-21 Sarco Temperature Regulator
B — No. 2430 Sarco Temperature Regulator
C — TR-19 Sarco Temperature Regulator
D — Sarco Float-Thermostatic Trap
E — Sarco Strainer
F — Sarco Sight Glass
G — Sarco Inverted Bucket Trap
H — Sarco Dial Thermometer
J — Sarco Water Blender

Sketch illustrates application of Sarco specialties on domestic hot water storage tank, fuel oil heater and converter for space heating.

DEPENDABLE water heater control

5 POINTS TO CHECK! For hot water always at the desired temperature—never too hot or too cold—without attention,

insist on SARCO Temperature Regulators and Water Blenders

1. *Trouble-free design*—at the right are a few of the many Sarco temperature regulator installations which give years of maintenance-free operation.
2. *Self-operated* and self-contained—do not depend upon outside sources of power, such as compressed air, electricity or water.
3. *Full modulating action*—valve operated by thermostatic system *filled with oil*—which expands *uniformly* with temperature. NO dependence upon critical vaporizing temperatures of volatile fluids.
4. *Wide range of adjustment* above and below factory setting. Your choice is not limited to "standard ranges."
5. *No troublesome stuffing boxes*—Sarco *packless* seals used for valve stems. NO leaking, sticking, or repacking.

Before you buy . . . compare with SARCO

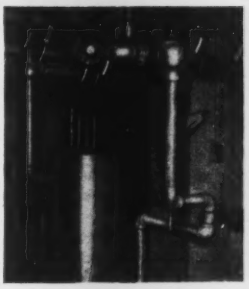
Write for Catalog 600-14 for full information on various types of Sarco Temperature Regulators and Water Blenders. Ask for a questionnaire on which you can report your exact requirements. Sarco Company, Inc., Empire State Bldg., New York 1, N.Y. Branches in principal cities. Sarco Canada Ltd., Toronto 8, Ontario.

SARCO saves steam

a sarco temperature control for every job

Sarco type TR-21 self-operated temperature regulators on service water storage tanks from twin heaters as installed some years ago in dormitories at University of Michigan, Ann Arbor, Michigan.

Sarco type 2430 temperature regulator on instantaneous water heater supplying water at various constant temperatures to experimental extruding machines at Western Electric Company's vast wire and cable plant at Point Breeze, Md. In use since 1948.



2½" Sarco Water Blender type MB as installed some years ago in the dormitories of University of Michigan to reduce washroom and shower water temperatures from 180°F., to a constant 120°F.

403

You don't have to heat-treat pre-hardened U·S·S Carilloy FC steel —it's quenched and

Heavy-duty shafts made without heat-treating — At the Monongah, W. Va., maintenance shop, Consolidation Coal Co. uses U·S·S CARILLOY FC steel for heavily-stressed repair parts for their mining equipment. Each new part must be as strong or stronger than the original that it replaces—and without benefit of heat-treating after machining. Pre-hardened, free-cutting CARILLOY FC is giving excellent service in shafts, axles, pins, screws, and other high-strength parts, and it is easier to machine than comparable alloy steels.

You can make all of these parts with U·S·S CARILLOY FC steel

Arbors	Chain Pins	Dies	Gears	Nuts	Racks	Spring Collets
Armature Shafts	Chuck Bodies	Die Bodies	Guide Pins	Pinch Bars	Ratchets	Straightening Rolls
Axles	Chisels	Drift Pins	Hammers	Pinions	Reamer Bodies	Studs
Ball Bearings	Chisel Bushings	Drill Shanks	High Tempered Bolts	Pins	Reamer Shanks	Swaging Rolls
Ball Races	Clash Gears	Elevating Screws	Hydraulic Rams	Pipe Cutter Wheels	Rollers	Tap Shanks
Brake Press Dies	Clutches	Embossing Dies	Jigs	Piston Rods	Screws	Tool Bodies
Blanking Dies	Collets	Expanding Mandrels	Keys	Pitman Screws	Screw Drivers	Tool Post Screws
Bolts	Connecting Rods	Feed Screws	Knuckle Pins	Plastic Molds	Shafts	Trimming Dies
Boring Bars	Connecting Rod Bolts	Forge Hammers	Knuckle Shafts	Pliers	Shear Blades	"U" Bolts
Bucket Teeth	Coining Dies	Forge Rams	Lead Screws	Power Drive Bits	Sleeves	Universal Joints
Bushings	Crankshafts	Forming Dies	Mandrels	Propeller Shafts	Sleeve Shafts	Valve Studs
Cams	Cutter Bodies	Forming Rolls	Master Hobs	Punches	Spindles	Worms
Chain Links	Cylinder Head Studs	Gauges	Molds	Races	Spline Shafts	Wrenches

Increases production of high-strength parts—Clearfield Machine Co., Clearfield, Pa., uses CARILLOY FC steel for the shafts of practically all their heavy-duty clay mixing machinery. In the 7½-ton Maximuller, CARILLOY FC has three important advantages. With a tensile strength of 140,000 to 165,000 psi., it provides a high factor of safety to withstand huge bending and twisting loads. It provides the required hardness of 258-331 Brinell with no need for heat-treating after machining. It makes possible much faster machining with better surface finish than comparable alloy steels.

tempered at the mill

● U·S·S CARILLOY FC steel is *ready for use* when it's delivered. With it you can fabricate gears, shafts, cams, axles, and other high-strength parts without heat-treating them after machining. This free-cutting pre-hardened manganese-chrome-molybdenum steel comes to you already heat-treated within the hardness range of 255 to 375 Brinell and with a tensile strength ranging from 125,000 to 175,000 psi. With CARILLOY FC steel, you save the expense of additional heat-treating and you eliminate rejects caused by distortion and scaling.

ITS BETTER MACHINABILITY PAYS OFF

CARILLOY FC saves you money on machining too. It cuts easily; so you can machine parts faster and, at the same time, get much longer service from your tools than with *any other steel* that has comparable hardness and strength. Shops that use this free-cutting steel report much faster machining with better surface finish. And tools last as much as 3 times longer.

READILY AVAILABLE—REASONABLE IN COST

In spite of its many money-saving advantages, CARILLOY FC costs only slightly more than ordinary through-hardening alloy steels; and you can get it promptly in all standard bar forms and sizes.

Send the coupon for complete information, or contact the nearest U·S·S District Sales Office.

GET COMPLETE INFORMATION

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Please send me a free copy of your new booklet, "CARILLOY FC Steel, Free-cutting and Pre-hardened," which contains complete technical information about CARILLOY FC steels.

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Company .....

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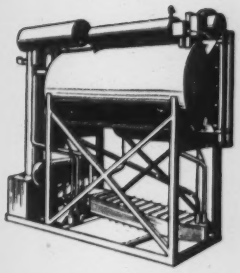

The Servel 25-ton water chiller has low floor loading, no vibration and quiet operation. It can be installed on any floor with most economical piping arrangement.

Investigate the proved advantages of Servel . . . There's a Servel unit or combination that will provide the best *in air conditioning at the lowest operating and upkeep cost. Mail the coupon* today *for full information.*

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Recently the Sturtevant Division of Westinghouse introduced another major advance in fan design—the new Airfoil-Bladed Centrifugal Fan. Now, just off the press, is a new catalog describing it in full detail.

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Peak Efficiency .....90% *plus*
Noise Intensity .....65% *less*

Wherever a lower operating cost means more than first cost—where evaluation and a reasonable price mean more than a low price—the Westinghouse Airfoil, Non-Overloading Fan is the answer.

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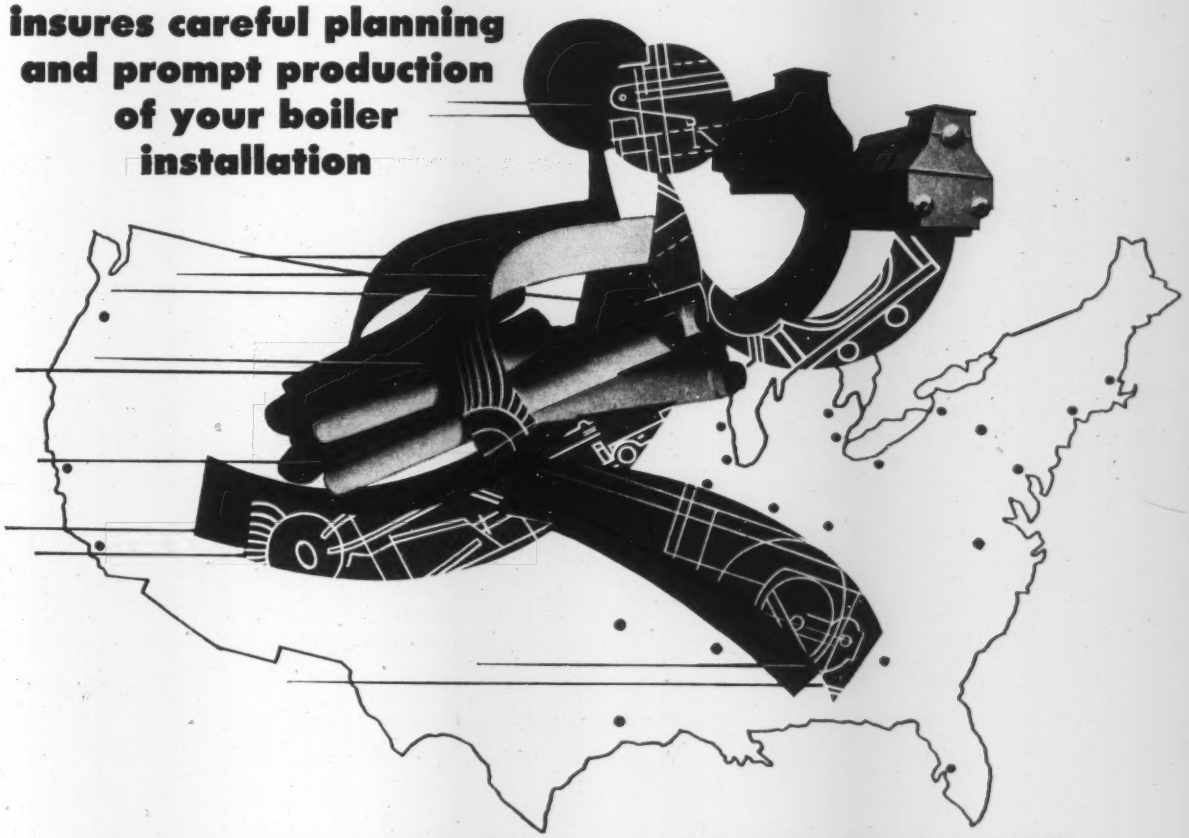

When you need steam generating equipment, you want to be able to work out your requirements with experienced men who are near at hand and know boilers thoroughly. That's where WICKES can help you, because WICKES has factory-trained sales engineers in twenty-three principal cities in the United States and several industrial centers outside the country. These men are ready to help you plan your new boiler installation.

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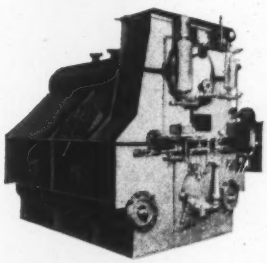
WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi.—all types of multiple drum boilers, adaptable to any standard method of firing. Write today for descriptive literature or consult your nearest WICKES representative.



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146

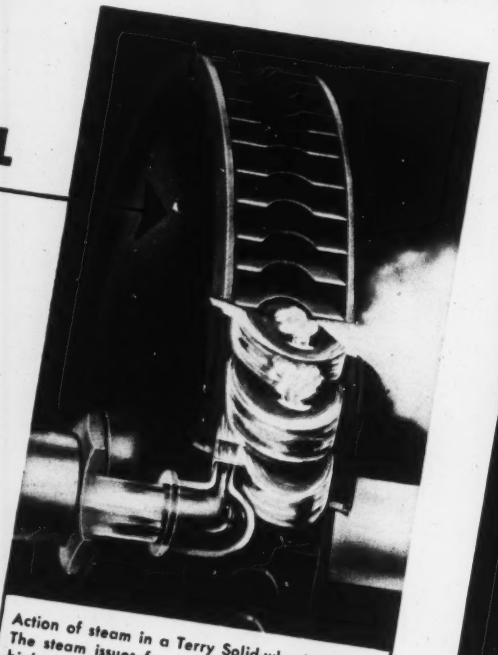
TERRY

THIS TURBINE WHEEL

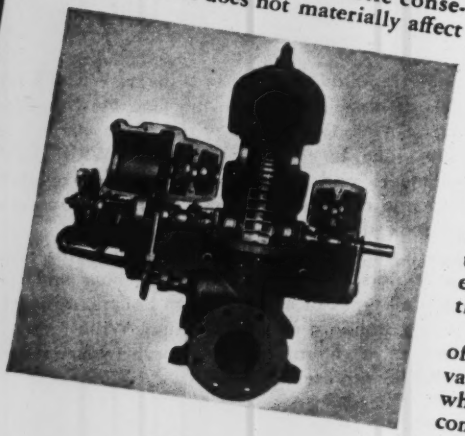
has no parts to loosen or work out

The rotor of the Terry Solid-wheel Turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to become loose or work out.

The power-producing action of the steam takes place on the curved surfaces at the back of the buckets. Hence, wear of the blades is of little consequence, as it does not materially affect horsepower or efficiency. There is practically no end thrust since the steam enters and leaves the wheel in a direction at right angles to shaft.



Action of steam in a Terry Solid-wheel Turbine. The steam issues from an expanding nozzle at high velocity and enters the side of the wheel bucket where its direction is reversed 180°. As this single reversal uses but a portion of the available energy, the steam is caught in a stationary reversing chamber and returned again to the wheel. This process is repeated several times until practically all of the useful energy has been utilized.



This is only a small part of the story of the many advantages of the Terry Solid-wheel Turbine. Write for complete details.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

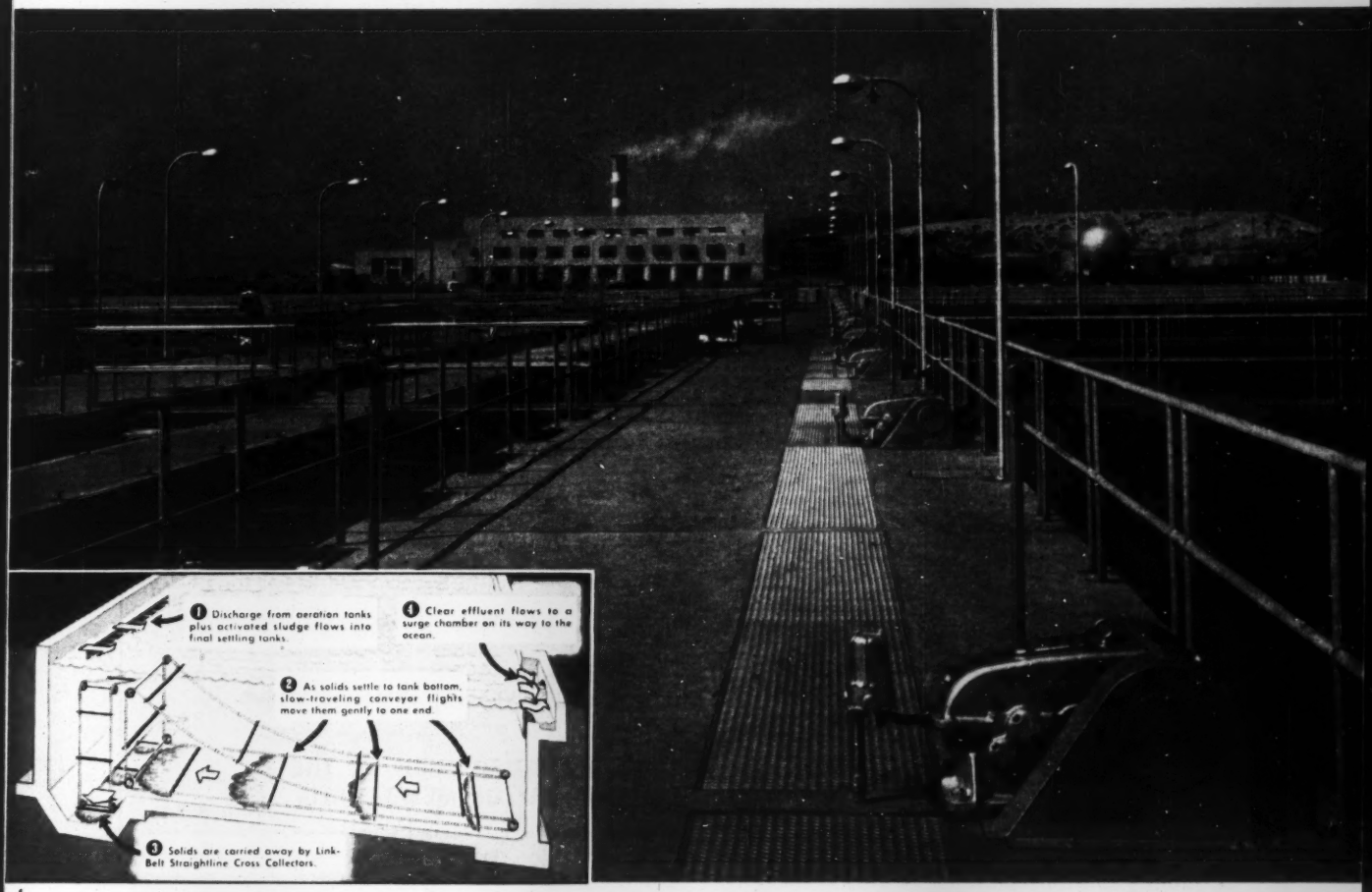
TT-1189

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

Link-Belt Research and Engineering . . . Working for Industry

How to turn a city's sewage into fertilizer, fuel and clean water!


1 Discharge from aeration tanks plus activated sludge flows into final settling tanks.
4 Clear effluent flows to a surge chamber on its way to the ocean.
2 As solids settle to tank bottom, slow-traveling conveyor flights move them gently to one end.
3 Solids are carried away by Link-Belt Straightline Cross Collectors.

Storm peaks of 420,000,000 gallons per day can be treated at the $41,000,000 Hyperion plant. Photo and schematic drawing show Link-Belt Straightline Collectors of which there are 100 in the final settling tanks. Plant designed under direction of Lloyd Aldrich, City Engineer, and Metcalf and Eddy of Boston.

New Los Angeles Sewage treatment plant uses 100 LINK-BELT Straightline Sludge Collectors

FOR 10 years, the city of Los Angeles had 12 miles of beach quarantined. Then they decided to do something about it. They eliminated the source of pollution with the opening of the Hyperion activated sludge plant. Covering 75 acres, this modern plant is designed to serve 3,000,000 people.

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In hundreds of cities, large and small, Link-Belt equipment is used for the purification of water supply as well as for sewage treatment. And industry relies more and more on this equipment for salvaging valuable solids from waste . . . simultaneously preventing pollution of lakes and rivers.

Helping guard the nation's health is just one result of continuous Link-Belt research and engineering. In almost every industry, you'll find Link-Belt conveying, processing and power transmission machinery speeding production, cutting costs, making America better through greater productivity.

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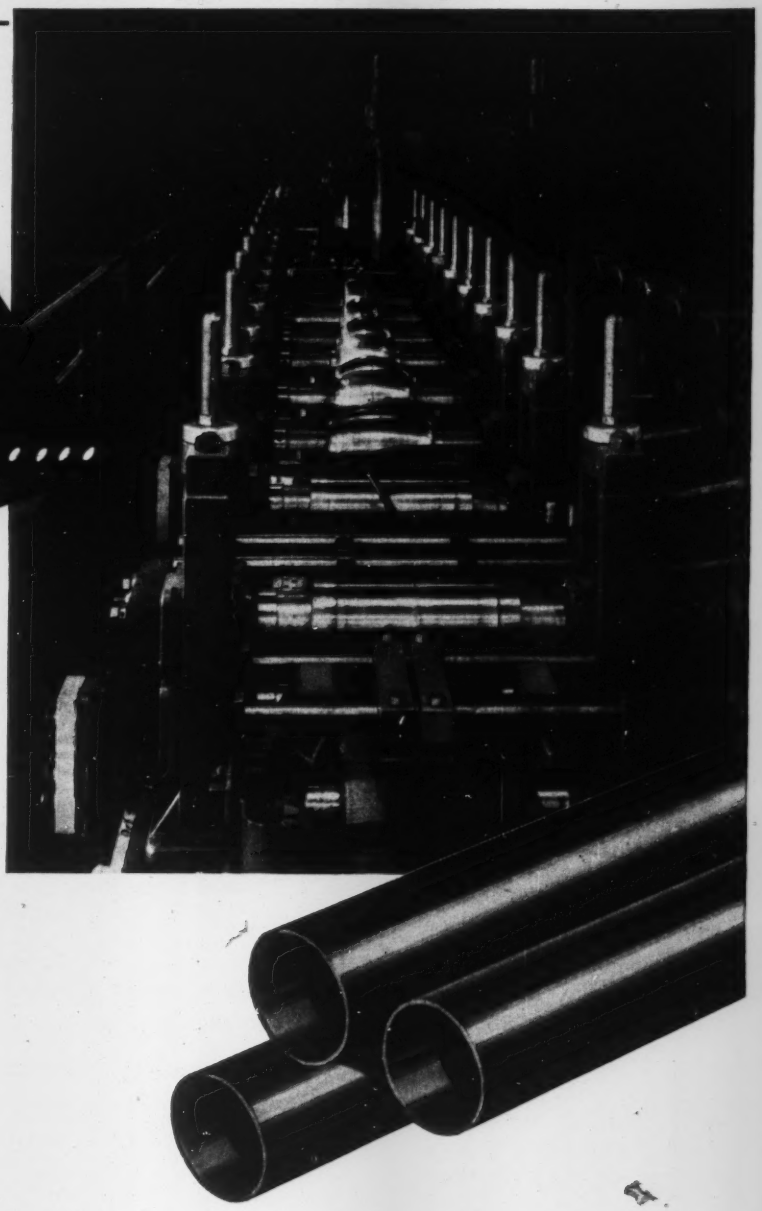

may be governed by a great many factors such as first cost, operating cost, speed, capacity, power consumption, etc. Mechanical and electrical features of the tube forming, sizing and welding units in themselves must be carefully examined. However, no matter how necessary or important all such details may be—or how effectively they may be presented—the most convincing proof of superiority is obtained by a comparison of tonnage production, consistently maintained over the years, of high quality tubes.

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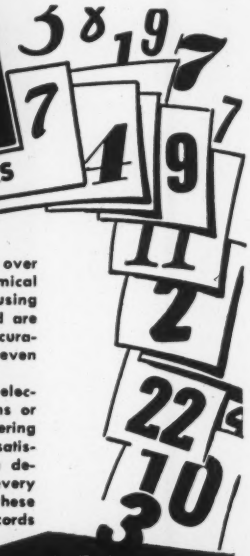

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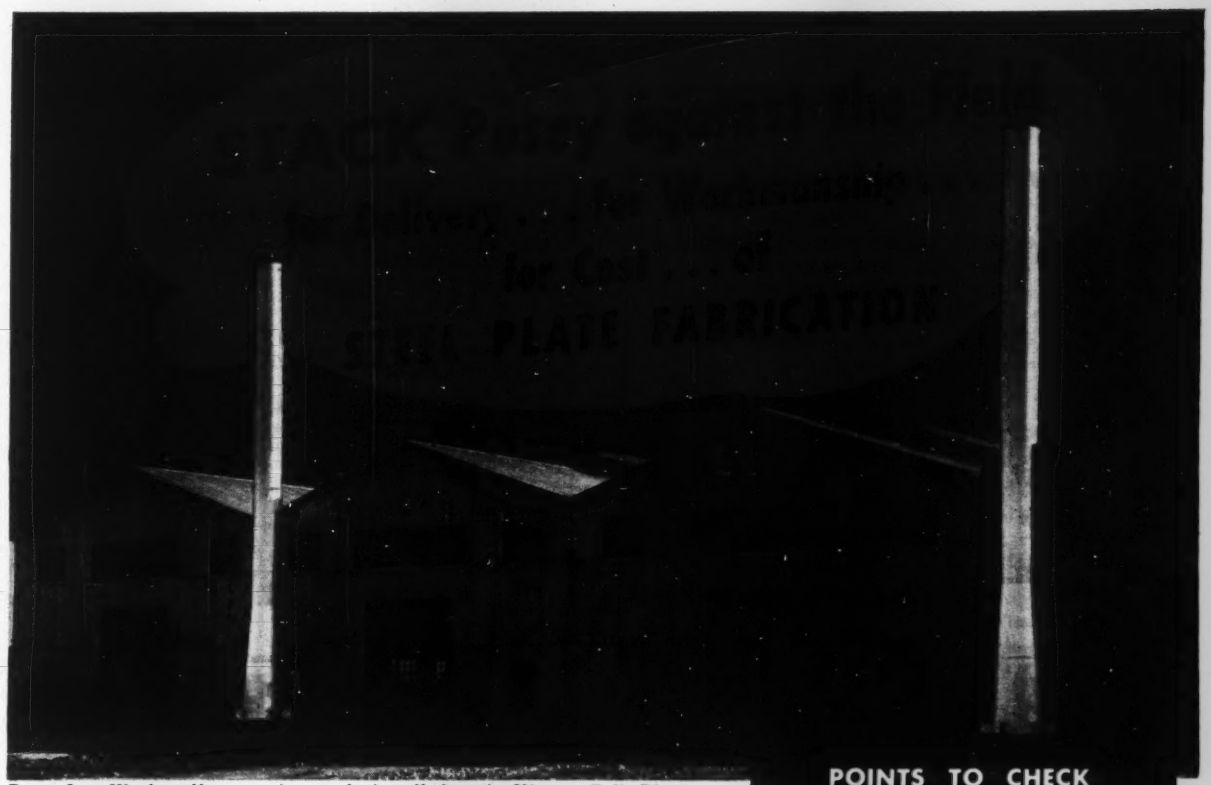

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Posey Iron is really "stackin' 'em up" for industries large and small. Stack buyers find that stacks by Posey Iron are sound in workmanship . . . competitive in cost . . . and delivered on date of promise.

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Posey Iron does the complete job . . . design . . . fabrication . . . erection. 16½ acres of plant under roof promote smooth flow of production. Shipping is facilitated by favorable location in a key rail and road center — Lancaster, Pa.

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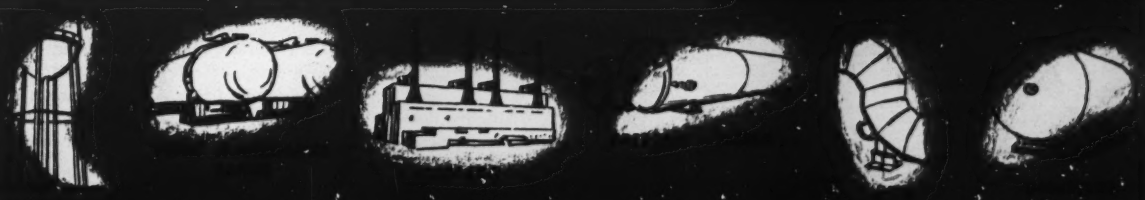
Posey Iron WELCOMES requests for further information.



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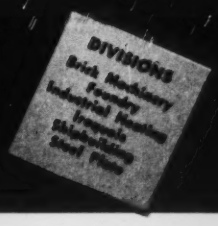

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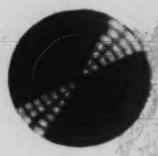

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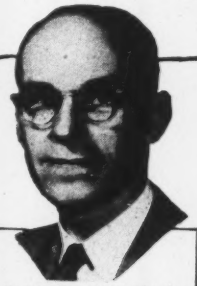

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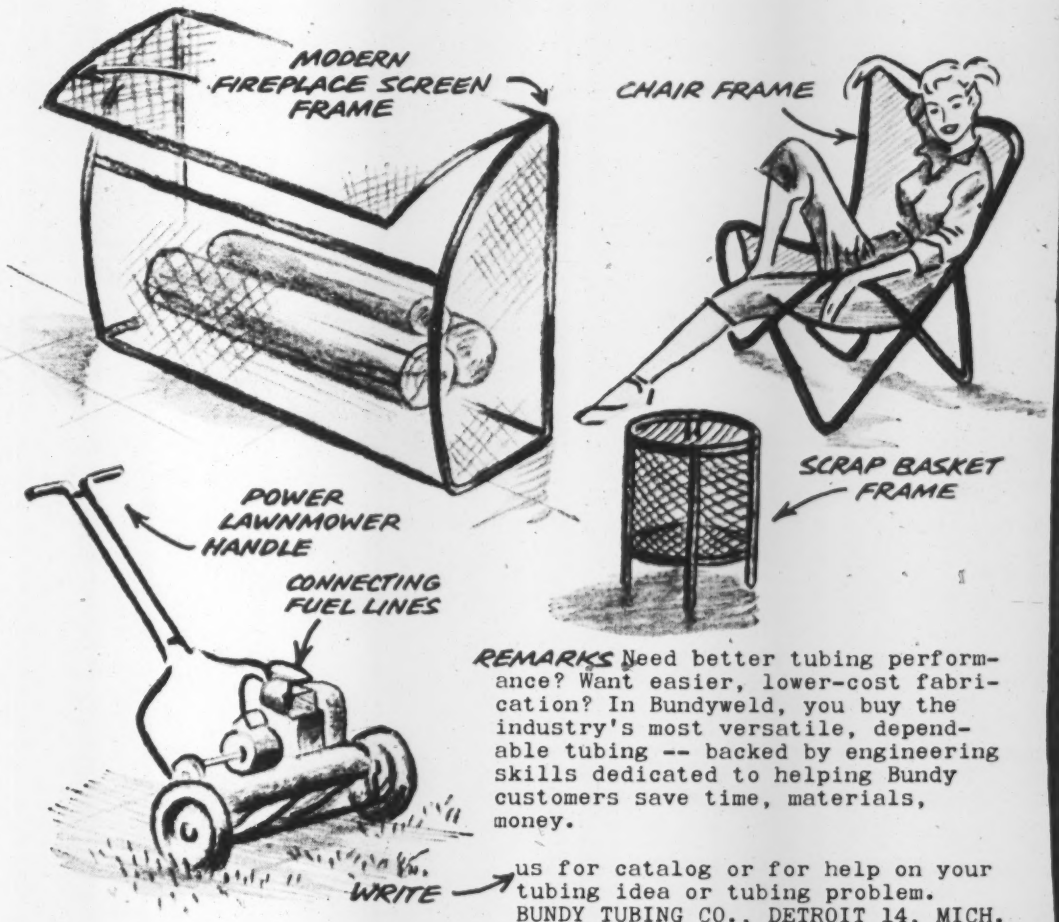

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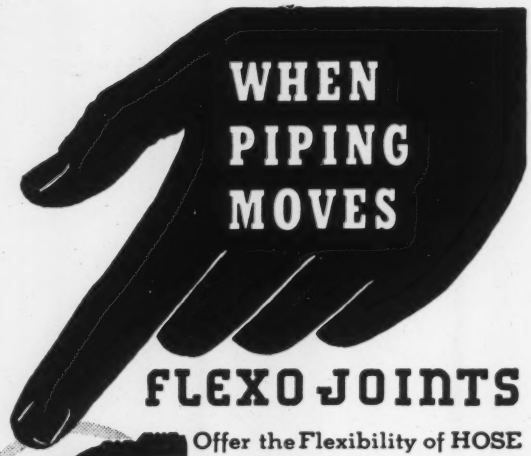

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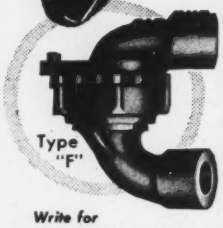

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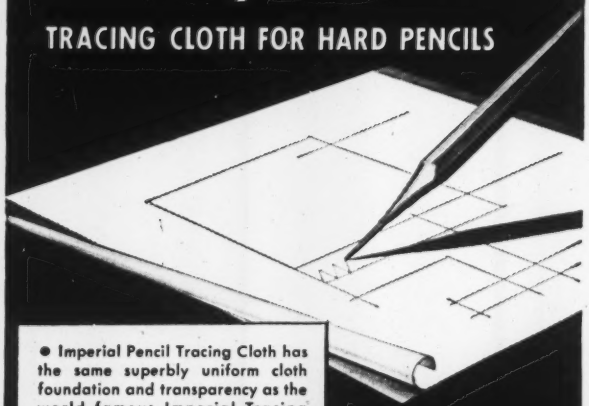

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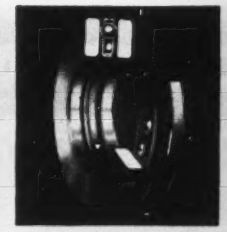

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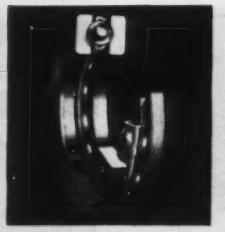

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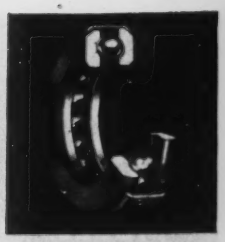

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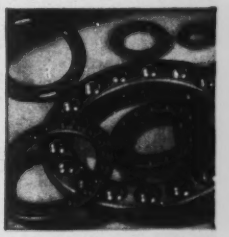

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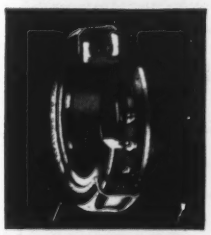

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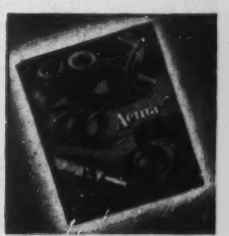

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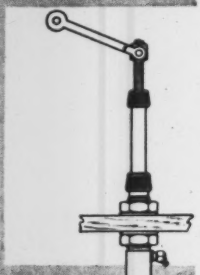

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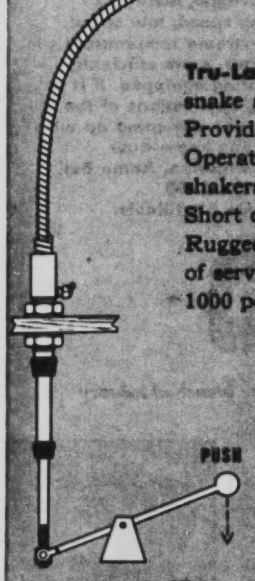

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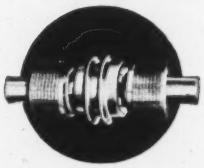

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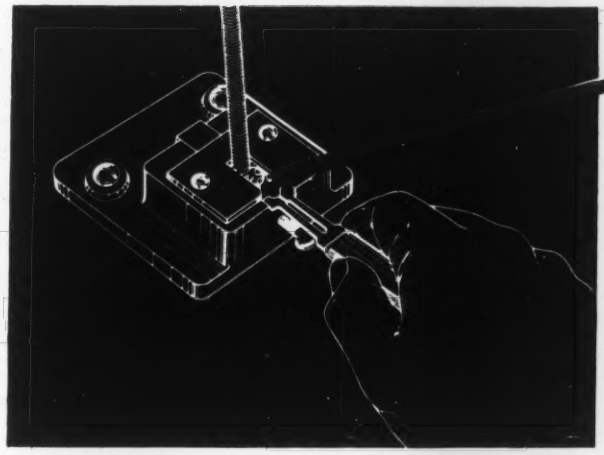

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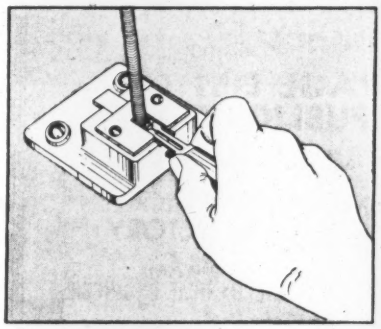

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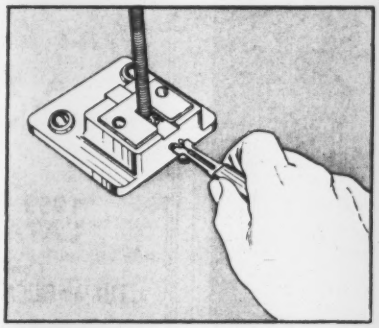

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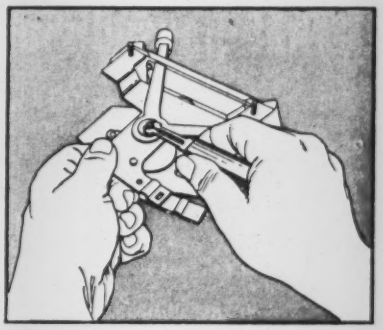

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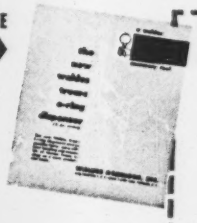

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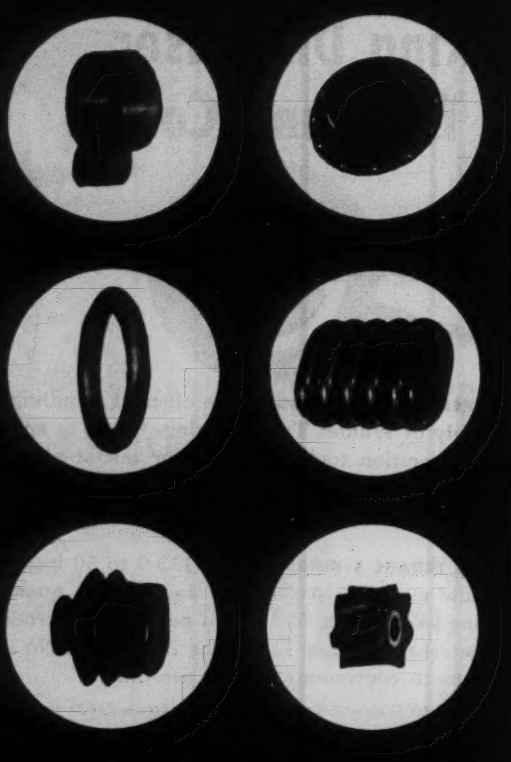

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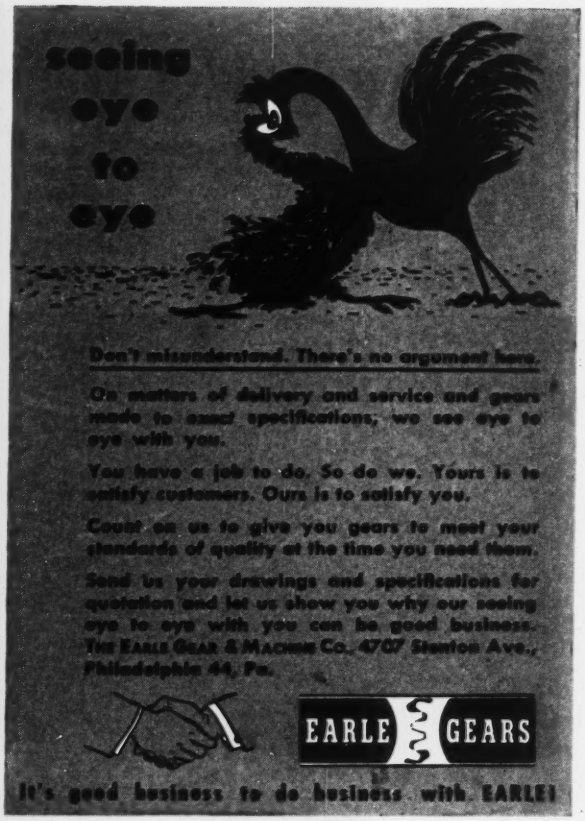
Whenever you require accurately dimensioned seals or odd-shaped parts of natural or synthetic rubbers, fluorethylene polymers or silicones, consult LINEAR in the design stage. Let LINEAR transform your ideas into precision-moulded finished goods.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.


seeing eye to eye
Don't misunderstand. There's no argument here.
On matters of delivery and service and gears made to exact specifications, we see eye to eye with you.
You have a job to do. So do we. Yours is to satisfy customers. Ours is to satisfy you.
Count on us to give you gears to meet your standards of quality at the time you need them.
Send us your drawings and specifications for quotation and let us show you why our seeing eye to eye with you can be good business.
THE EARLE GEAR & MACHINE CO., 4707 Stanton Ave., Philadelphia 44, Pa.
EARLE GEARS
It's good business to do business with EARLE!

For Reference

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is included in the

1953 ASME MECHANICAL CATALOG AND DIRECTORY

Copies of the List are obtainable from

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Publication-Sales Dept.

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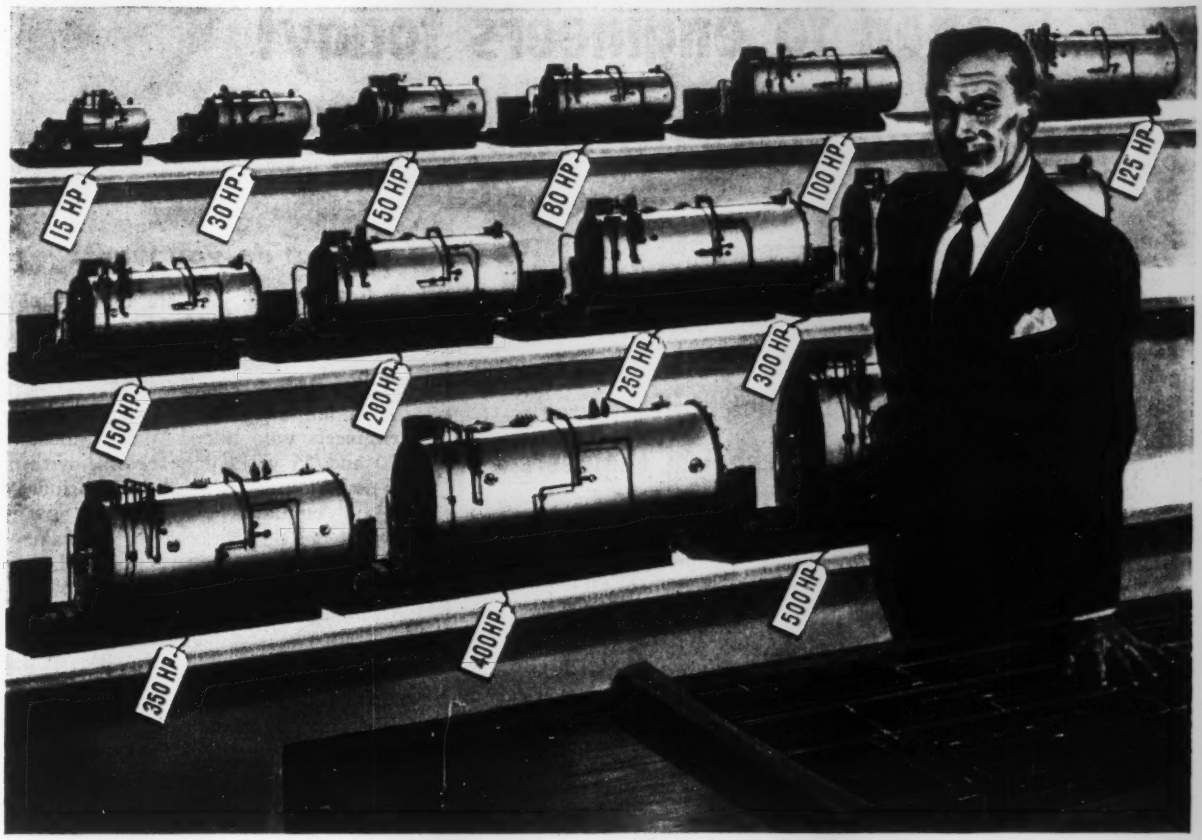
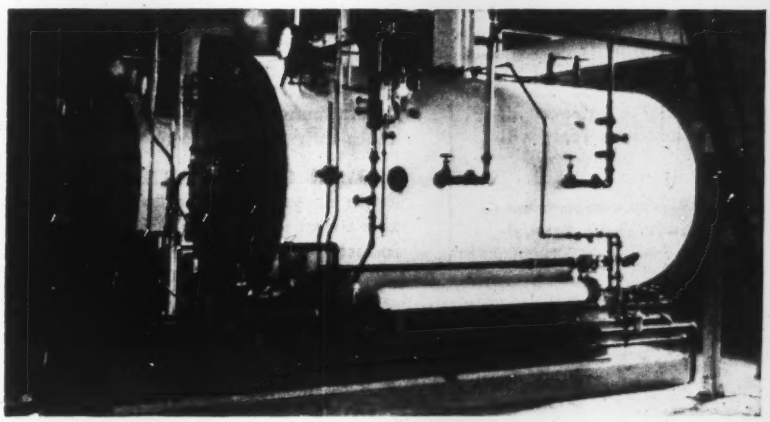


Cleaver-Brooks does not sell steam boilers "off the shelf" even though the boilers are available in standard models. Working with you, your engineers, and your consulting engineers Cleaver-Brooks helps analyze your particular steam needs and loads, both present and future.

These are a few of many factors considered: steam requirements in pounds per hour or b.h.p. — constant or fluctuating loads — fuels available — electric current characteristics — space and boiler room layout — provision for expansion.

Application engineering assistance of this kind assures you a steam plant tailored for your job. Cleaver-Brooks are the first and finest in modern, self-contained steam boilers — operate at a guaranteed efficiency of 80% — burn the fuel most available and economical in your area, gas, oil, or combination gas and oil — fully meet all codes — standard models available in sizes 15 to 500 hp; 15 to 250 p.s.i.

Write for latest, fully illustrated and descriptive Cleaver-Brooks Steam Boiler catalog.



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STEAM BOILERS

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Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners

There are hundreds of jobs open to engineers today!

but few opportunities like these

Westinghouse is in nuclear power to stay. We believe in the development of atomic energy as man's next great source of power. If you want to get in on a new era in industry, we want to talk to you.

Atomic power opportunities are waiting now for mechanical engineers with 4 to 10 years of this kind of experience...

DESIGN OR APPLICATION—light and heavy structural supports for machinery... high pressure piping and systems... rotating machinery ... steam turbines, general steam apparatus and steam power systems... heat exchangers and condensers ... hydraulic apparatus and systems, fluid flow, systems evaluations, heat balance, valve design ... mechanical and hydraulic devices and mechanisms (thorough knowledge of properties of materials required).

LIAISON—coordination with subcontractors and customers ... scheduling and planning of ship trials and customer testing of nuclear powered steam plants.

SUPERVISION of drafting work.

REMEMBER! We are primarily interested in good *experienced* application and development engineers—lack of previous reactor development experience *is no handicap in this type of work.*

HOW TO APPLY! What Westinghouse wants to know is: Where and when you obtained your degree ... how you did in school ... where you have worked at your profession ... what kind of work you have done.

In other words, right now we're more interested in your ability to fill current openings and to develop in the Westinghouse Atomic Power Division than we are in your vital statistics. Write your letter of application accordingly.

You will be in communication with men who are experienced in keeping secrets. All negotiations will be discreet, and your reply will be kept strictly confidential.

Address your application letter to: Manager, Industrial Relations Department, Westinghouse Electric Corporation, P. O. Box 1468, Pittsburgh 30, Pennsylvania.

What do you want?

MONEY? Good jobs are open here now—waiting for good men who want to make a permanent connection.

A PERMANENT JOB? Many of the engineers who joined Westinghouse 20 and 25 years ago are still with Westinghouse—and in key positions—and engineers who join us now will have the opportunity to make this work their lifetime careers. When many other industries may be going through slack times, atomic energy will still be in a stage of expansion.

SUBURBAN LIVING? It's here—within easy driving distance of your work. Within a few minutes of shopping centers ... schools ... metropolitan centers.

JOB EXTRAS? Westinghouse offers: Low cost life, sickness and accident insurance with hospital and surgical benefits. A *modern* pension plan. Westinghouse stock at favorable prices. Westinghouse appliances for your home at discount.

YOUR KIND OF ASSOCIATES? Every fourth person in the Division is an engineer or scientist. More than half the top Westinghouse executives are engineers.

FASCINATING WORK? What other branch of science offers such exciting challenges? So many opportunities for discovery? So many chances to benefit mankind? So many opportunities for original work?

GROWTH OPPORTUNITIES? Never again in your lifetime will you be able to get into such a sure-to-expand industry so early in its development.

YOU CAN BE SURE.. IF IT'S Westinghouse

FARVAL—*Studies in Centralized Lubrication* No. 139

Farval Announces DC 20 Automatic Pumping Unit for complete lubrication of smaller machines

ALL PARTS OF THIS NEW FARVAL DC20 *automatic pumping unit are assembled on a single base plate ready for quick, easy mounting at any convenient point. Supply lines run from the pumping station to the Dualine measuring valve manifolds, one valve for each bearing to be lubricated. The entire system is installed very simply and at a cost that will be repaid in a few months in savings effected.*

NOW any small machine can have a completely automatic system of Farval centralized lubrication—as efficient and economical as the larger systems which have proved so valuable on heavy industrial equipment during the past 26 years.

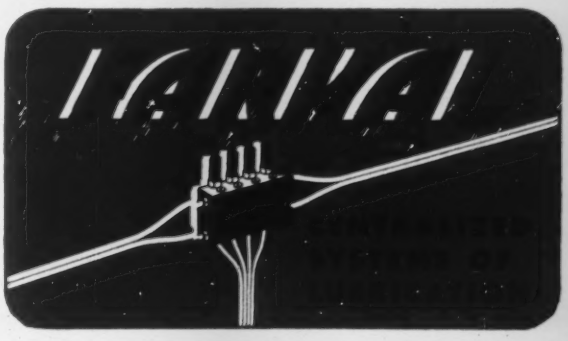
Chief component of this smaller, low cost system is the new Farval DC20 pumping unit which handles either grease or oil. In addition to the pumping unit, the complete Farval system consists of two main supply lines, the familiar Dualine measuring valves and discharge line connections from measuring valves to the bearings.

Easily installed at any convenient place on or near a machine, the DC20 insures automatic delivery of lubricant to bearings, as often as needed, in whatever quantities desired, while the machine is in operation. Remember that Farval—and Farval only—employs the Dualine valve that is fully adjustable—simple, sure and foolproof—with a positive indicator which visually signals that the valve has functioned.

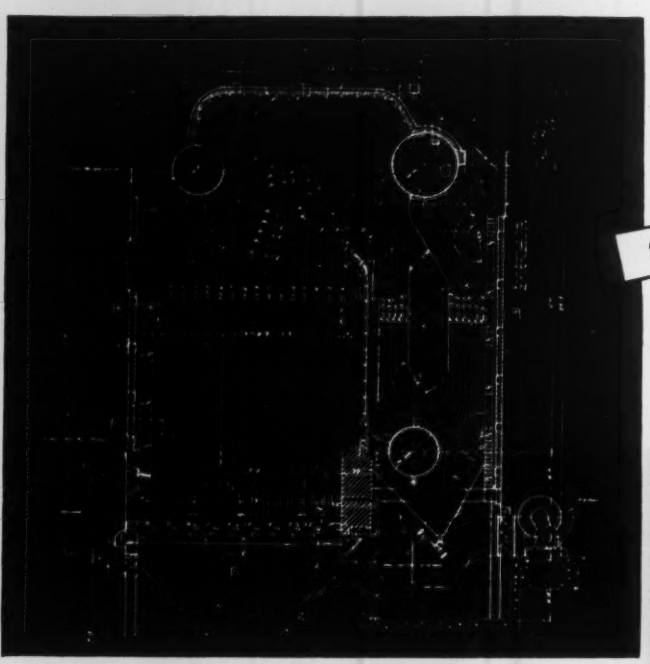
Hundreds of operators using the larger Farval automatic systems have discovered that the entire cost of a system is saved the first year. Lubricant savings alone may run as high as 75%.

Investigate the new DC20. Near you is an experienced Farval lubrication engineer who will demonstrate how the new DC20 pumping unit can save time and money and increase production on your present hand-lubricated machines. Write today for a copy of Bulletin 39, "DC20 Pumping Unit for Smaller Machines". The Farval Corporation, 3264 East 80th Street, Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.



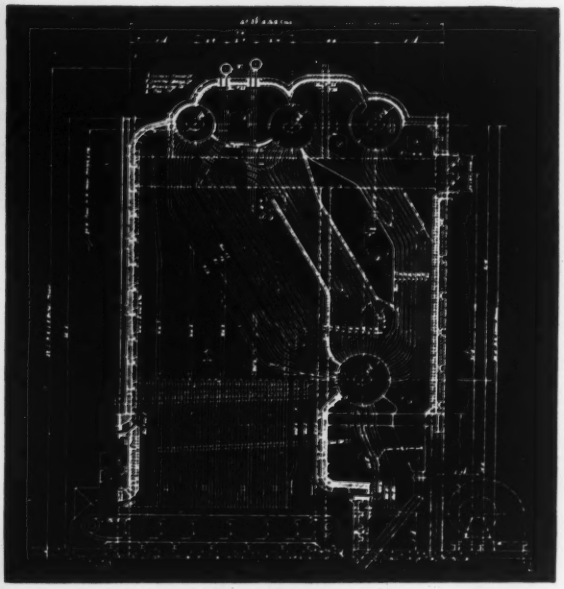
Quick Steaming at all Ratings!



Carry high overloads with high efficiency

SPECIFY Vogt

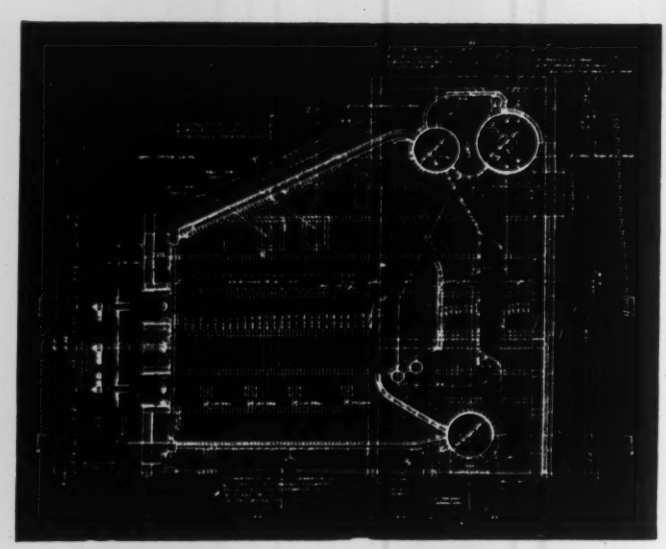
STEAM GENERATING UNITS



CLASS VL — Two 27,500 pounds per hour units, installed at Brown-Forman Distillers Corporation, Louisville, Ky. Features large furnace volume in limited space, with high ratio of radiant heating surface.

CLASS LE — Mt. Carmel Public Utility, Mt. Carmel, Illinois, is served by this 60,000 pounds per hour unit. Generous steam liberating surfaces and steam space permit wide fluctuations in load.

CLASS VR — 70,000 pounds per hour steam generator at Humble Oil and Refining Company, Johnsue, Texas. An efficient, high-duty unit with water cooled furnace, using refinery gas fuel.



Vogt builds a complete line of bent tube steam generators, designed to burn solid, liquid, or gaseous fuels to meet specific operating conditions. Superheaters, air preheaters, economizers, water walls, and soot blowers can be readily incorporated. Bulletins with general information and showing typical installations are available upon request.

HENRY VOGT MACHINE CO.

LOUISVILLE 10, KENTUCKY

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NEW YORK, PHILADELPHIA, CLEVELAND
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Positions Open—Positions Wanted—Equipment, Material, Patents, Books, Instruments, etc. Wanted and For Sale

Answers to box number advertisements should be addressed to given box number, care of "Mechanical Engineering," 29 West 39th St., New York 18, N. Y.

POSITIONS OPEN

RATES Classified Advertisements under this heading in MECHANICAL ENGINEERING are inserted at the rate of $1.70 a line. $1.35 a line to members of ASME. Seven words to the line average. A box number address counts as one line. Minimum insertion charge, 5 line basis. Display Advertisements carried in single column units of multiples of one inch at flat rate of $28 per inch per insertion. Copy must reach us not later than the 10th of the month preceding date of publication.

TECHNICAL WRITER

Good, permanent opportunities for engineering or journalism graduates with experience or training in both fields. To write and edit application engineering material for use of engineers in the field. Reply giving details of education and experience to: Employment Manager, Supervisory and Technical Personnel.

CARRIER CORPORATION
SYRACUSE, NEW YORK

MECHANICAL DESIGN ENGINEER

To design automatic machines for production of electronic tubes. Five to ten years' responsible experience in design of medium weight automatic machinery required. Vacuum tube equipment experience is desirable but not mandatory.

Permanent position with opportunities for advancement in new and expanding division, not dependent on defense contracts. Interesting and varied projects. Excellent salaries. Attractive working and living conditions, life and health insurance.

WESTINGHOUSE ELECTRIC CORPORATION
ELECTRONIC TUBE DIVISION
P. O. Box 284 Elmira, New York

Product Engineers having at least five years' experience in the design of piping components, preferably forged steel fittings and flanges. Experience in design or detailing of fabricated pipe at least partially acceptable in lieu of experience in fitting and/or flange product design. Knowledge of welding practice in piping industry, familiarity with grades of pipe steels and applicable material and dimensional standards, some understanding of pipe fabrication or erection practices, flexibility design, drafting room practice, ability to write clear and concise reports, are all desirable but not essential. In first letter state full qualifications in line with above desired capabilities plus any others which you think may qualify you for important position on engineering staff of this large midwest manufacturer. Also state salary requirements and present connection. All replies will be held in strict confidence. Salary $7200 per year or more, depending on qualifications.

Personnel Director
Tube Turns, Inc.
224 E. Broadway
Louisville 1, Ky.

MECHANICAL ENGINEER

We need one experienced BS or MS Mechanical Engineer for design, construction and maintenance work in connection with bench scale and pilot plant research in coal processing. This position offers an exceptional opportunity for advancement both in research and in anticipated commercial fields. Replies including education, experience, references, salary desired and recent photograph should be directed to:

Pittsburgh Consolidation Coal Company
Research and Development Division
Library, Pennsylvania
Attention: William F. Saalbach
Adviser on Personnel

ENGINEERS AND PHYSICISTS BS-MS-PH.D.

Responsible positions in mechanical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years' experience in experimental research design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential. Ind. Rel. Manager, Research & Development Dept.

PHILLIPS PETROLEUM COMPANY
Bartlesville, Oklahoma

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Positions available for Design Engineers with experience in the design of mechanical equipment used in Blast Furnaces, Open Hearth Furnaces, Sintering Plants, Rolling Mills and other auxiliary plants for the processing and production of iron and steel. These men must have experience in Steel Plant layout as well as the design of equipment involved. These are permanent positions with excellent advancement opportunities for qualified Engineers who are interested in greater accomplishment.

If you qualify and are interested in advancing with a continually expanding organization, write, giving complete resumé of positions held and duties performed, education, age, salary desired, etc., to:

ARTHUR G. McKEE & COMPANY
2300 Chester Avenue
Cleveland 1, Ohio

MECHANICAL ENGINEER

Responsible permanent position in new section of established company.

Graduate, age 35-50, experienced in chemical industry design including pressure vessels, piping, materials and specifications.

Paid holidays . paid vacation . low cost group health, accident, and life insurance . retirement plan.

Salary commensurate with ability and experience.

Submit resumé of personal history . education . experience . salary expected.

Application confidential.

DIRECTOR OF DEVELOPMENT
NITROGEN DIVISION
ALLIED CHEMICAL & DYE CORPORATION
ORGANIC DEPARTMENT
HOPEWELL, VIRGINIA

MACHINE DESIGNERS

Design of automatic and semi-automatic equipment used in manufacture of vacuum devices, 4 or 5 years' allied experience desirable. Attractive salary. Excellent opportunity to join new expanding electronic division. Send complete resumé.

WESTINGHOUSE ELECTRIC CORP.
P. O. Box 284
Elmira, New York

It will pay you to read the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

Frankly, working at North American requires hard thinking and plenty of vision. Because North American always works in the future. Yet, if you are interested in advanced thinking, if you'd like to work on the planes that will make tomorrow's aviation history, you'll like working at North American. North American offers these extra benefits, too.

North American Extras—

Salaries commensurate with ability and experience • Paid vacations • A growing organization • Complete employee service program • Cost of living bonuses • Six paid holidays a year • Finest facilities and equipment • Excellent opportunities for advancement • Group insurance including family plan • Paid sick leave • Transportation and moving allowances • Educational refund program • Low-cost group health (including family) and accident and life insurance • A company 24 years young.

Write Today

Please write us for complete information on career opportunities at North American. Include a summary of your education, background and experience.

CHECK THESE OPPORTUNITIES AT *North American*

- **Aerodynamicists**
- **Stress Engineers**
- **Aircraft Designers and Draftsmen**
- **Specialists in all fields of aircraft engineering**
- **Recent engineering graduates**
- **Engineers with skills adaptable to aircraft engineering**
- **Electrical and Electronic Engineers**

NORTH AMERICAN AVIATION, INC.

Dept. 6, Engineering Personnel Office
Los Angeles International Airport
Los Angeles 45, Calif.; Columbus 16, Ohio

North American Has Built More Airplanes Than Any Other Company In The World

TECHNICAL PERSONNEL

looking for
INCREASED RESPONSIBILITY
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- POWER GENERATION and DISTRIBUTION
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- PILOT PLANT and TEST LOOP OPERATIONS and DESIGN
- HEATING, VENTILATING, AIR CONDITIONING, and DUST CONTROL

METALLURGY

investigate opportunities at our

ATOMIC ENERGY INSTALLATIONS

Send resumé and salary information requesting detailed information concerning Openings, Company Policies and Community Life

TECHNICAL PERSONNEL OFFICE

CARBIDE AND CARBON CHEMICALS COMPANY
a division of
UNION CARBIDE AND CARBON CORPORATION
POST OFFICE BOX P, OAK RIDGE, TENN.

MAKE USE OF THE OPPORTUNITIES SECTION

If you desire capital or have it to invest; if you have a patent for sale or development; if you have on hand used machinery for disposal, or if you want such equipment; if you have copies of publications, or a set of drawing instruments to dispose of; if you need help or want a position, in fact, anything to be offered that somebody else may want, or anything wanted that somebody else may have—use a classified advertisement in MECHANICAL ENGINEERING for quick results.

AT NORTH AMERICAN AVIATION

Guided missile and rocket engine developments at North American are years ahead in engineering and design. More than five million man-hours' experience in actual rocket engine firing tests, for instance, contribute to North American's substantial leadership in this challenging phase of aerophysics.

North American's stature in this exciting and complex field is the result of three things: The foresight to plan ahead for the nation's future needs; a stimulating, side-by-side cooperation among the best engineering brains in the industry; and the immediate availability of North American's extremely advanced research and test facilities to its aerophysics personnel. One such facility is the Aerophysics Field Laboratory, shown above. Another is the world's largest privately-owned supersonic wind tunnel. There are many more.

There are always career opportunities at North American for imaginative scientific minds. A brighter future for you may be here at North American—in the field of airframe design, structures and stress, propulsion systems, special mechanical equipment, aerodynamics or flight test instrumentation and operations.

Why not write for complete information, giving us your education and experience?

NORTH AMERICAN AVIATION, INC.

Engineering Personnel, Missile and Control Equipment Department

12214 Lakewood Boulevard, Dept. 95-M, Downey, California

NORTH AMERICAN HAS BUILT MORE AIRPLANES THAN ANY OTHER COMPANY IN THE WORLD

MECHANICAL ENGINEERS

BENDIX RADIO will suit you to a "T"

We need Mechanical Engineers to work on design of small mechanisms, light structures, gear trains, chassis and packaging units as applied to electronics communications equipment.

Men we want must have M. E. or A. E. degree, with one or more years experience in mechanical design.

Positions involve board design, model shop association and construction-testing of primary models.

You benefit from excellent starting salary, ideal working conditions in modern plant, paid vacations and holidays and good chance for rapid advancement. Housing immediately available in beautiful suburban and country areas that surround the Bendix plant.

Write, wire or phone
MR. E. O. COLE, Dept. M

Bendix Radio
DIVISION OF BENDIX AVIATION CORP.
BALTIMORE-4, MD. Phone: TOWSON 2200

ENGINEERS AND DESIGNERS

with creative ability and a sincere interest in stable employment wanted by a medium size well-known machine tool company. Openings exist in research, machine design and equipment design divisions due to present and projected design of new products. Applicants with working knowledge of machine hydraulics, servomechanisms and electrical components desired. Company is located in a pleasant, progressive New England village having good recreational facilities, modern schools, hospital, etc. Excellent working conditions and congenial atmosphere.

Address CA-4199, % "Mechanical Engineering."

RESEARCH CHEMISTS, PHYSICISTS, ENGINEERS

The following additions to our permanent staff are needed for research on smokeless powder, rocket propellants, detonators, dynamites, and other explosives chemicals.

Chemists
Chemical Engineers
Physicists
Mechanical Engineers
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Experienced men particularly needed for responsible work: salaries commensurate. Staff positions also available for chemical or mechanical engineer in estimating cost of proposed research processes and in market studies; also research librarian.

Desirable insurance, retirement, holiday and vacation plans. Expanding diversified company makes advance possible to various fields. Submit detailed resumé including salary requirement.

Employment Manager
OLIN INDUSTRIES, INC.
Explosives Division
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NEEDED to work on
AIRCRAFT TURBINE ENGINE
DESIGN and DEVELOPMENT

ALLISON HAS IMMEDIATE OPENINGS FOR:

- MECHANICAL ENGINEERS
- AERONAUTICAL ENGINEERS
- ELECTRICAL ENGINEERS
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If you'd like to know more about YOUR opportunity with ALLISON—and the many advantages awaiting the qualified engineer at ALLISON—investigate NOW. Send a brief summary of your education, work experience and qualifications—along with a recent photo—to:
R. G. GREENWOOD, *Salaried Personnel*
Dept. 153

Allison DIVISION GENERAL MOTORS CORPORATION • Indianapolis, Ind.

Design, development and production—high power TURBINE ENGINES for modern aircraft . . . heavy duty TRANSMISSIONS for Ordnance and Commercial vehicles . . . DIESEL LOCOMOTIVE PARTS . . . PRECISION BEARINGS for aircraft, Diesel locomotives and special application.

It will pay you to watch the announcements on these pages for an opportunity that you may be looking for or one that may be of interest to you.

CHALLENGING JET PROBLEMS FOR CREATIVE ENGINEERS

- **Reducing jet engine cost and weight by using plastics.**
- **Developing materials capable of withstanding 2000 degrees F.**
- **Designing lightweight, reliable electronic control circuits.**
- **Increasing air flow through a fixed diameter compressor.**

These are typical problems that General Electric engineers face and solve in the design and development of new and advanced aircraft turbojet engines at Jet Center, U.S.A. near Cincinnati, Ohio.

The solutions to jet engine design problems depend upon imaginative minds. Keen analytical thinking and vision are "musts" in this rapidly-advancing field.

If these are the challenges you seek, your opportunity is available with G.E. at Evendale, Ohio, headquarters for General Electric's Aircraft Gas Turbine Division.

Here you will be part of the great and growing American jet engine industry that G.E. pioneered just 10 years ago! You will work with other top creative engineers who are probing into the vast unknown areas of jet propulsion.

Here are the opportunities open to you with General Electric in the jet engine industry:

AERODYNAMICS	HEAT TRANSFER
FLUID MECHANICS	HYDRAULICS
THERMODYNAMICS	ELECTRONICS
TESTING	INSTRUMENTATION
WELDING	LUBRICATION
VIBRATION AND DAMPENING	METALLURGY
LABORATORY ENGINEERING	FLIGHT MATHEMATICS
STRESS ANALYSIS	FIELD ENGINEERING

CREATIVE MECHANICAL DESIGN
SERVO-MECHANISMS

Positions are available at West Lynn, Mass. and Cincinnati, Ohio. Please do not apply if your best skills are being used for vital defense work. Send your resume to: Technical and Supervisory Personnel, Aircraft Gas Turbine Division, Dept. M.

GENERAL ELECTRIC
P.O. BOX 196 CINCINNATI 15, OHIO

TURBOJET ENGINEERS — Future jet problems at G.E. need the knowledge, creative thinking, and stamina of keen-minded engineers. Independent thought coupled with joint endeavor produce new and better jet engines.

IN NAVY BLUE — New fighter for the Navy's carrier fleet is the North American FJ-2 "Fury." Powered by a new model of the combat-proved J47 engine, this Navy fighter will be a potent part of America's air arm. Among other planes powered by G-E jets are Boeing's B-47 Stratojet bomber, and North American's F-86 Sabrejet fighter and F86-D Sabrejet Interceptor.

MECHANICAL ENGINEER

Large engineering and construction firm has permanent staff position open for mechanical engineer with experience in steam electric station operation to engage in plant betterment work which involves assistance in starting new units, testing, advising and consulting in respect to operating problems, improving steam plant efficiencies, advising in respect to procedures and maintenance practices, related problems. Reasonable knowledge of water treatment problems, practices, etc., desirable. Substantial traveling involved. Salary commensurate with experience, and attractive company benefits. Give full particulars, age, education, experience in detail, and salary expected.

Address CA-4161, % "Mechanical Engineering."

MECHANICAL ENGINEERS

We are looking for mechanical engineers, with experience in the design of small intricate mechanisms, to work in the development of business machines. Plenty of opportunities for advancement.

Write, giving full details, including education and experience.

THE NATIONAL CASH REGISTER CO.
South Main and "K" Streets
Dayton 9, Ohio

CIVIL ENGINEERS
MECHANICAL ENGINEERS

Applications from outstanding Design and Research Engineers are now being sought by a progressive, well-known independent research and development organization to meet its expanding volume of work in the field of Applied Mechanics. Mechanical design, and civil engineers with experience or advanced training in the following fields are especially needed:

Fluid Mechanics
Heat Transfer
Jet Propulsion
High-Speed Automatic Mechanisms
Rotating and Reciprocating Power Equipment
Materials Engineering
Structural Mechanics
Thermodynamics

Exceptionally capable men in related fields will also be considered. The Armour Research Foundation, operating in affiliation with the Illinois Institute of Technology, offers a unique opportunity for challenging research in a variety of fields. Staff members are encouraged to take advantage of the readily available opportunities for advanced study and for professional development.

Send a full statement of academic and experience qualifications to

C. E. Barthel, Jr.
Assistant Director
ARMOUR RERESARCH FOUNDATION
OF
ILLINOIS INSTITUTE OF TECHNOLOGY
Chicago 16, Illinois

Additional Opportunities are offered in the display advertisements— on pages 57, 64, 120, 123, 126, 130

ENGINEERS

FOR ATOMIC WEAPONS INSTALLATION

Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

These are permanent positions with Sandia Corporation, a subsidiary of the Western Electric Company, which operates the Laboratory under contract with the Atomic Energy Commission. The Laboratory offers excellent working conditions and liberal employee benefits, including paid vacations, sickness benefits, group life insurance and a contributory retirement plan.

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Healthful Southwest

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet. Cosmopolitan shopping centers, scenic beauty, historic interest, year 'round sports, and sunny, mild, dry climate make Albuquerque an ideal home. New residents experience little difficulty in obtaining adequate housing in the Albuquerque area.

THIS IS NOT A
CIVIL SERVICE APPOINTMENT

Make Application to the
PROFESSIONAL EMPLOYMENT DIVISION

SANDIA
Corporation
SANDIA BASE
ALBUQUERQUE, N. M.

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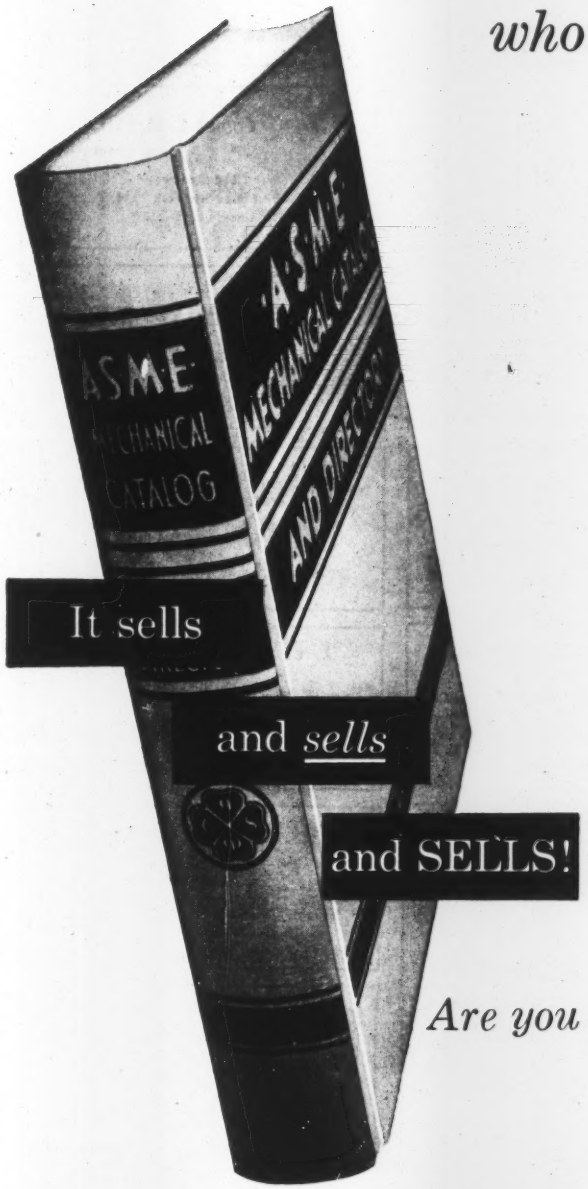

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It adds miles to your voice

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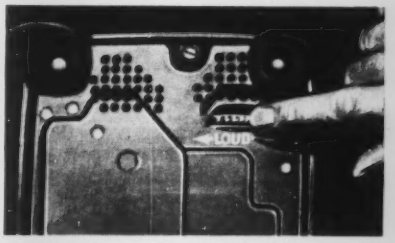
For years the telephone you know and use has done its job well—and still does. But as America grows, more people are settling in suburban areas. Telephone lines must be longer; more voice energy is needed to span the extra miles.

Engineers at Bell Telephone Laboratories have developed a new telephone which can deliver a voice ten times more powerfully than before. Outlying points may now be served without the installation of extra-heavy wires or special batteries on subscribers' premises. For shorter distances, the job can be done with thinner wires than before. Thus thousands of tons of copper and other strategic materials are being conserved.

The new telephone shows once again how Bell Telephone Laboratories keeps making telephony better while the cost stays low.



Adjustable volume control on bottom of new telephone permits subscriber to set it to ring as loudly or softly as he pleases. Ring is pleasant and harmonious, yet stands out clearer.

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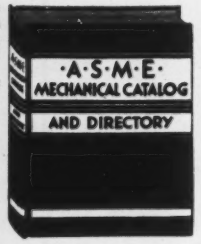

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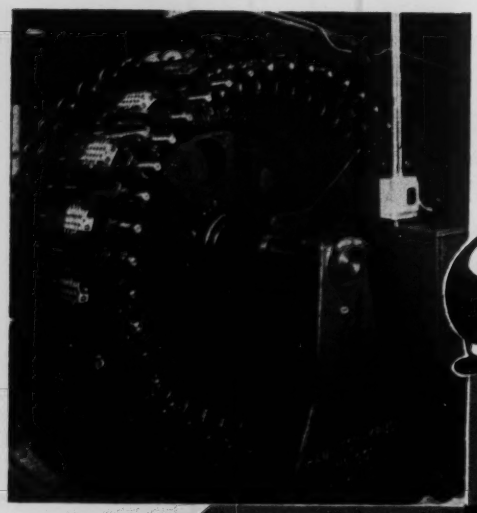
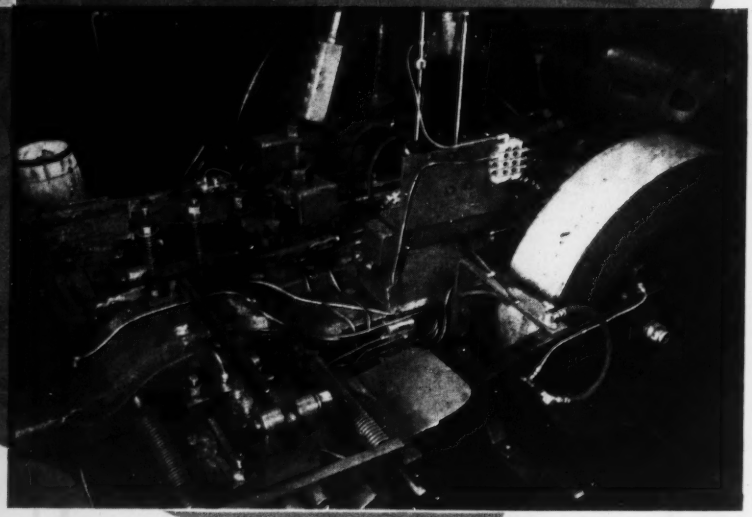


ENGINEERED LUBRICATION WILL CUT Maintenance Costs 90%

this has a BEARING on the subject



Properly planned and engineered lubrication can result in tremendous savings in your plant. Trabon Automatic Systems have been proving this in industry everywhere.

One example is shown above. The rivet heading machine illustrated, equipped with a Trabon Automatic System, has been in operation 3 years — and has never been down for bearing repairs. Lubrication is controlled by the start and stop of the machine, assuring the proper amount of oil to each point at all times.

In the second illustration, there are 221 lubrication points on this can machine. The Trabon system lubricates all bearings with a Trabon pump which rotates with the machine.

These two machines are merely typical of the thousands of Trabon Systems installed on equipment of all kinds over the past 22 years.

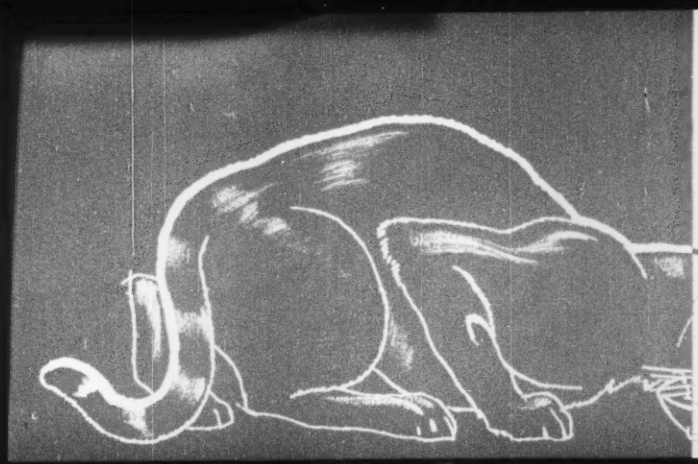
Trabon is a proven System, guaranteed to save money by reducing maintenance cost, and increasing your production.

A Trabon System is positive; hydraulic; handles oil or grease; is completely sealed; and has a single indicator at the pump which gives 100% proof that all bearings have been lubricated.

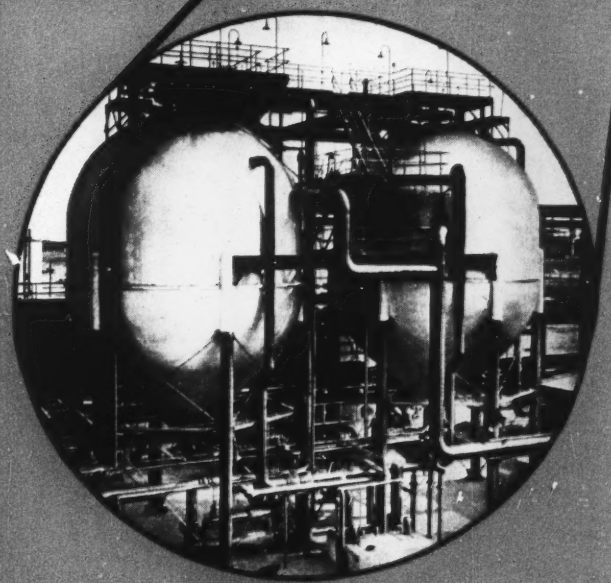
Ask us for Bulletin 529.

Trabon Automatic Lubrication Fits Any Bearing Situation.

Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems



BIG "CATS" NEED GOOD WATER TOO . . .



Permutit two-stage hot lime soda and phosphate water softener recently installed at The Texas Company's Eagle Point Refinery.

WATER CONDITIONING HEADQUARTERS FOR 40 YEARS

—*and Permutit Equipment brings it, at lower cost, to The Texas Company's new Eagle Point "cat" crackers . . .*

The Texas Company, at their Eagle Point Works in Westville, N. J., processes 60,000 barrels of crude per day, in which processing modern fluid catalytic cracking is used. Over-all refinery steam and electric power balance dictated refinery boiler plant operation at 900 psi. Treated water is used on waste heat boilers on the cat cracker. They operate a Permutit two-stage hot lime soda and phosphate water softener to protect their boilers against scale and corrosion. Permutit equipment and its location are illustrated.

The Texas Company is but one of many concerns which realizes the value of proper water softening. To solve water conditioning problems, manufacturers in hundreds of industries have turned to Permutit. With 40 years of experience in water treatment, Permutit possesses the know-how to solve water conditioning problems economically at lower initial cost, with greater continuing savings.

For aid in the solution of your own water problems, write to The Permutit Company, Dept. ME-2, 330 West 42nd Street, New York 36, N. Y. or to Permutit Company of Canada, Ltd., 6975 Jeanne Mance Street, Montreal.

PERMUTIT

Does 98 operations every 1.1 minutes with help of 216 TIMKEN® bearings

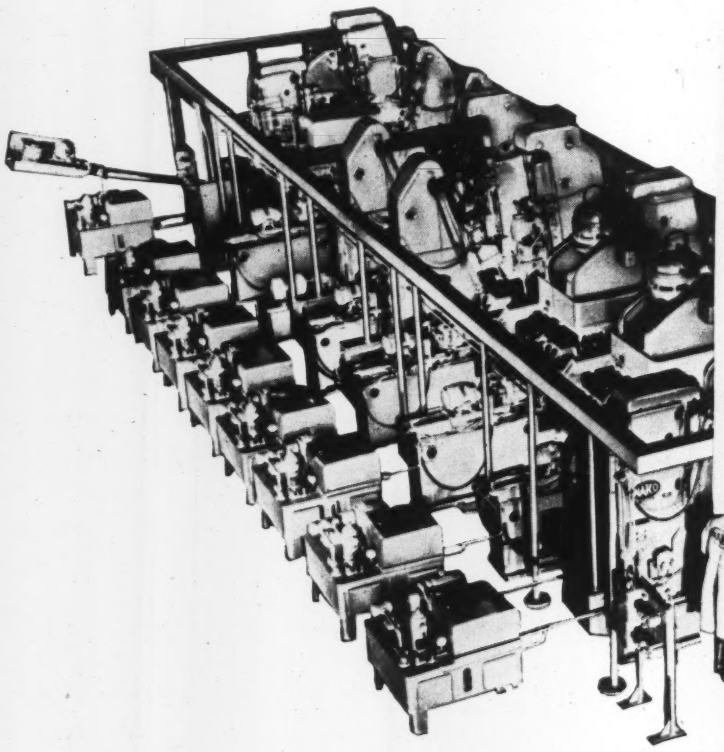
THIS Natco Holeway Automatic processing machine completes 98 pan face operations on an engine block every 1.1 minutes! Besides milling, drilling, trepaning, counterboring, reaming and chamfering, it automatically inspects the finished block! To insure precision and long life, National Automatic Tool Company, Inc. mounts the idler shafts and spindles on Timken® tapered roller bearings, and uses a total of 216 Timken bearings throughout the assembly.

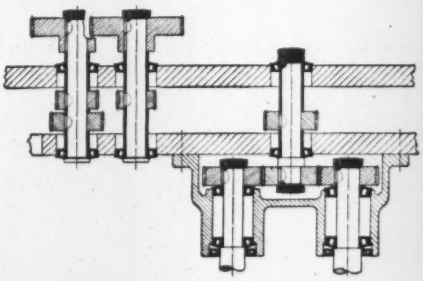
Because of their tapered construction, Timken bearings take radial and thrust loads in *any* combination. And line contact between rollers and races gives them extra load-carrying capacity. Shafts are held in rigid alignment. Gears mesh smoothly and accurately.

The true rolling motion and incredibly smooth finish of Timken bearings practically eliminates friction. They hold shafts and housings concentric, making closures more effective. Lubrication time and material costs are cut.

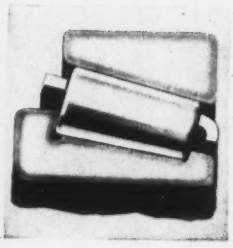
Timken bearings are engineered for the job, precision manufactured, and made of special analysis Timken fine alloy steel. Normally, they last the life of the machine. No other bearing can give you all the advantages you get with Timken tapered roller bearings. Specify them in the machines you build or buy. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.





How **NATIONAL AUTOMATIC TOOL COMPANY, INC.** mounts the idler shafts and spindles of its Holeway Automatic Processing Machine on Timken tapered roller bearings to insure precision and long life. In all, 216 Timken bearings are used throughout the assembly.



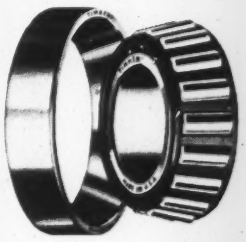
GREATER LOAD AREA

Because the load is carried on the *line* of contact between rollers and races, Timken bearings carry greater loads, hold shafts in line, wear longer.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⊂⊃ THE TIMKEN TAPERED ROLLER ⊂⊃ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION